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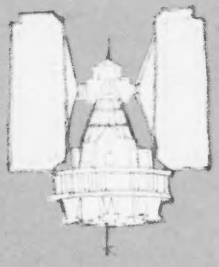

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MFR PAPER 1243

Past, Present, and Future Uses of Minced Fish

FREDERICK J. KING

Today, the state of evolution of minced fish utilization in the United States might be described as "the end of the beginning." Products made from minced fish have entered U.S. markets. Most of this production is based on imported minced fish blocks. Some, but not all, of the problems in introducing these new products can be traced to quality characteristics of these imports. Problem areas include variability between different sources of raw material, inconsistent quality from a given source of raw material, and deterioration of quality during frozen storage.

In the United States, present uses of minced fish include fish sticks, fish portions, salted fish, seafood patties, and other products made by extrusion. Most of our commercial use of minced fish blocks is for fish sticks. Fish portions are consumed, but there is a limited supply of truly white minced fish blocks for this application. A New England firm is test marketing salt fish produced from minced fish obtained from fish frames (backbones). Seafood patties and other extruded products have been produced or are being test marketed.

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Anticipated directions of future research and development cover the entire spectrum from harvest through processing, storage, marketing, and new product development. Several of these activities will occur overseas and will impact on U.S. consumption of minced fish products. Some thoughts about directions of these activities include the following: 1) Improve frozen storage stability of minced fish blocks and breaded products made from these blocks; 2) modify the texture or "mouth-feel" of minced fish products so that it is more akin to that of fillet products; and 3) in contrast, concentrate on development of new products based on the natural characteristics of minced fish, for example, mixtures with ground beef. In addition to needs for future research and development, international cooperation is essential to development of realistic product names and quality assurance documents for minced fish products consumed in the United States.

THE PAST

A relatively small quantity of minced fish blocks has been imported since, at least, the early 1960's. Most of these earlier blocks were made in Iceland or Canada using v-cuts (fillet trimmings containing rib bones). In the United States, some of these blocks have been used to make fish sticks from the early 1960's to now. Other blocks, having a less white appearance or a less fibrous texture, have been used to make fish cakes and other products.

The amount of imported minced fish blocks increased dramatically in the 1970's. In 1972-73, U.S. importers of fish blocks started feeling the pinch of short supplies and higher prices for the fillet blocks that had been used for making fish sticks and portions. They turned to minced fish blocks and to Alaska pollock fillet blocks to meet part of our consumer desires for sticks and portions. Consumer reactions in this initial period were mixed. By early 1974, our freezer warehouses were full of both fillet and minced fish blocks. The oil crisis of 1974-75 did not help matters since it kept block prices high and movement of these blocks was slow. During this period, the U.S. industry became painfully aware that minced fish blocks lost quality at a faster rate than fillet blocks during frozen storage. More and more consumers complained about poor quality of fish sticks made from minced fish. For example, complaints about rubbery texture could be traced often to the use of minced Alaska pollock blocks. Quantities of fish blocks in freezer warehouses finally returned to normal by mid-1975, and an "older but wiser" attitude is now prevalent.

Laminated blocks entered into U.S. production of fish sticks and portions recently. They are mixtures of fillets and minced fish in which the minced fish originates from fillet trimmings (such as v-cuts), and it is spread uniformly on fillet surfaces. The amount of minced fish may represent its

natural proportion in the headed and gutted fish. If laminated blocks contain too much minced fish, they are apt to fall apart or shatter during sawing. Laminated blocks, containing up to 10 percent (United Kingdom) or 12-14 percent (Norway) evenly distributed minced fish, have gained acceptance by U.S. producers of sticks and portions. Lamination represents a greater use of fish as food. Some earlier imports of "sandwich" blocks were rejected because they contained much more minced fish, and it was usually concentrated in the center of the block.

There have been attempts to produce minced fish blocks in the United States. They have been economically unsuccessful. Problems include how to gather enough raw material at one place to justify investment costs and how to develop suitable machines for processing a variety of materials. While supplies of imported minced blocks continue to meet U.S. needs, there is little incentive to produce domestic blocks. However, at least one U.S. firm is taking advantage of a local supply of fish frames (backbones) from filleting lines to make salted fish by a quick salting process based on minced fish.

THE PRESENT

Among U.S. users of minced fish blocks for making fish sticks or portions, appearance (color), texture, excessive thaw drip, blemishes, and consistency of quality are the most often mentioned shortcomings. These shortcomings are related to each other. For example, minced blocks derived from cod or haddock fillet trimmings (v-cuts) have a reasonably fibrous texture, a desirably white appearance, and a minimum of blemishes because their source material is free from skin and membranes. These qualities have diverted this supply of minced blocks into making more and more portions instead of sticks during the last few years. On the other hand, other source materials such as headed and gutted fish are much more abundant. Some of these source materials yield minced blocks that have too many blemishes or are too deeply colored (off-white) for use in fish sticks. These appearance defects can be partially removed, but there is a concurrent sacrifice in textural quality. Such blocks lack the "fibrous" or uniform appearance of "v-cut" blocks, and their texture is more apt to become elastic or rubbery after frozen storage. Some of these blocks have had too much thaw drip (excessive moisture) by the time they were made into fish sticks. Although this defect can occur in fillet blocks, the sponginess of minced blocks makes it more difficult to measure, as well as control, thaw drip in order to estimate their suitability for making fish sticks.

Problems with excessive moisture and rubbery texture in fish sticks made from some minced fish blocks have led some U.S. users to mix textured vegetable protein with the minced fish. These products have had better acceptability. If textured vegetable protein were added at the time the blocks were first made instead of thawing, mixing, and then freezing the minced fish a second time, quality of these products might be improved even more.

United States users of minced fish blocks have a limited experience with products other than sticks or portions. A breaded portion-like product was made from minced croaker. Its most noteworthy feature was an attempt to mimic texture of fillets by fashioning minced flesh into scallopy layers about ¼-inch (5-mm) thick, piling them, and cutting into the pile to make the "portions." Another breaded product was based on extruding minced croaker into a shrimp-like curl. Both of these croaker-based products failed due to marketing and technological difficulties. Current efforts are directed towards making croaker surimi blocks for export to Japan.

For minced fish blocks whose appearance (off-white color or too many blemishes) is not favorable in fish sticks, some limited product applications exist in the United States. These blocks continue to be used for making fish cakes. Gefilte fish is made in the United States using minced fish blocks from Canadian freshwater species. Minced fish has also been used to make frankfurter or sausage-type products. In the past 20 years, there have been several attempts to market them. Their success has been limited due mostly to marketing problems and, sometimes, technological problems. Present consumer demand for all of these products is significantly less than the potential supply of minced fish blocks from headed and gutted species.

Some U.S. firms are using minced fish blocks to make seafood patties. These breaded products usually contain seasoning and may contain small pieces of shellfish such as shrimp or clam. They represent a present use with a growth potential for those minced fish blocks whose appearance makes them less attractive for fish sticks.

THE FUTURE

The future of imported minced fish depends on how suppliers respond to U.S. market opportunities. There is considerable disenchantment based on our previous experience, especially with minced Alaska pollock blocks. In the near future, we may expect development of new extruded products, and also mixtures of fish and other ingredients. To improve textural quality, addition of textured vegetable protein has been suggested. Other suggestions include adding seasonings to improve flavor or using other additives to extend useful storage life. Some of these suggestions have been tested on imported minced fish blocks. It is generally agreed that any of these additives should be mixed with minced fish where the blocks are made instead of reworking the blocks in the United States.

Regarding the longer range future supply of minced blocks in the United States, four suggestions are offered: 1) Improve packaging; 2) improve market names; 3) improve quality and useful storage life; and 4) develop alternate marketing directions.

With the exception of surimi blocks, most imported minced fish blocks have had the same waxboard packaging as fillet blocks. By the time they are received in the United States, most of them have dehydration on their edges, sides, and top where the waxboard carton had come loose during handling. It seems obvious that minced fish would lose moisture at a faster rate during frozen storage because it lacks the tissue structure of fillets. A simple overwrap with a plastic moisture-barrier film appears to be a feasible solution. It would help maintain integrity of the waxboard carton as well as inhibit loss of moisture. Its cost should be outweighed by an improvement in quality and storage life of the imported minced fish blocks.

In the United States, market names for species of fish have been a complicated topic except, perhaps, for those people near our coastline. This situation is becoming even more complicated as "new" species arrive at our ports. The potential supply for minced fish can compound this problem

since some species now have unattractive names or none at all save their taxonomic name. The National Marine Fisheries Service has started a "Plan for Market Names of Fishery Products." It calls for a fishery product to be identified by an appropriate group name. Each group would have a descriptive, one word name, and the total number of food groups would not exceed 30. These group names would be based on edibility characteristics instead of biological or taxonomic ones. This plan is an ambitious undertaking that requires agreement between industry, government, and consumers.

There is an ancient saying in food technology that it is harder to substitute a new ingredient in an existing product than to develop a new product which uses the natural characteristics of this new ingredient. This saying applies to minced fish blocks. For production of fish sticks and portions, the best sources of minced blocks come from fillet trimmings (v-cuts). Minced blocks derived from headed and gutted fish usually have defects of off-white appearance, blemishes, or rubbery texture for these applications. Since the potential supply of headed and gutted fish is far greater than that of fillet trimmings, there is a clear-cut need to develop alternate marketing directions for these sources of minced fish. Some U.S. research activities in this direction are outlined in the following paragraphs.

When headed and gutted fish are used to make minced fish, white or black belly membranes and blood-rich tissues can cause blemishes to the appearance of this minced fish if not removed beforehand. There is a need for more versatility, capacity, and automation in equipment which provides the material for meat-bone separators. This need has stimulated machine development for those fish which are unsuitable for filleting. Fish can now be beheaded, eviscerated, split, and washed in a single machine which provides virtually blemish-free material to a meat-bone separator. This study includes development of grading and sorting equipment as well as suitable equipment to unload a fishing vessel rapidly. Attention has also been given to storage of a "mixed bag" (those fish which are harvested but which have been unwanted) on a fishing vessel (1).

Storage studies of minced fish blocks are underway in several laboratories. These studies are based on several undervalued, headed, and gutted species obtained from Atlantic, Pacific, or Caribbean waters. The studies include processing variables such as washing the minced flesh before freezing, the use of various additives, and packaging the blocks in plastic films which have low moisture or oxygen permeability. Most of these studies have not yet reached their completion (see 1, 2, 3).

There is considerable interest in using additives with minced fish to extend its useful storage life. By now, it is generally recognized that a minced fish block is more susceptible to the effects of storage conditions than a fillet block. Changes in texture or in flavor are especially noticeable.

To inhibit textural deterioration in commercial, frozen-stored minced fish blocks, tripolyphosphate or other condensed phosphates have been used. These compounds are used successfully to preserve fillet blocks during frozen storage. In the case of minced blocks, addition of these compounds involves a more uniform distribution of phosphate throughout the mass of flesh, and the flesh itself has lost most of its original structure as a consequence of mincing. Recent research results suggest that these phosphates may cause, not inhibit, development of a tough, rubbery, undesirable texture (2). Even salt (sodium chloride) by itself may be an undesirable additive in minced fish blocks (2).

To inhibit development of rancid or bitter off-flavors in frozen-stored minced fish blocks, several antioxidants have been proposed. Among the phenolic food antioxidants (such as BHA, BHT, PG, and TBHQ), the most effective additive appears to be TBHQ (2), but there are practical difficulties in controlling the addition of any of these lipid-soluble antioxidants to minced fish muscle (1). Sodium erythorbate (a compound closely related to ascorbic acid) can inhibit development of off-flavors in frozen-stored minced fish, and it has advantages of water solubility and it is generally recognized as a safe additive (1). Related studies are demonstrating that proper packaging such as Saran-wrap[1] can inhibit oxidative rancidity and dehydration in frozen-stored minced fish (1).

The concept of mixing species is gaining acceptance in the case of minced fish products. Many of the physical characteristics which distinguish flesh of one species of fish from another disappear as a consequence of meat-bone separation. The flesh itself is more readily identified as minced than of the species from which it was derived. However, problems exist in identifying particular species which might be mixed together for food applications. Most of the recent work in chemical aspects of this problem has been from the Halifax Laboratory, Fisheries and Marine Service, Halifax, N.S., Canada. A physical aspect of this problem has been identified in the case of species which have undesirably soft texture. Arrowtooth flounder or soft Dover sole can be blended with firmer textured species (such as rockfish) so as to take advantage of the desirable flavor of flounder and, in effect, eliminate the problems associated with using these soft textured species (2).

The color of minced fish from headed and gutted species or from frames (backbone material after filleting) and its nutritional attributes suggest use as an extender for red meat products. Our published work suggests several possible applications (1). More recent work includes mixing minced Pacific hake flesh or rehydrated drum-dried hake protein with ground beef to make "beefish" patties (2). Results of cooking tests indicate that addition of rehydrated fish protein reduces moisture loss during cooking (2). The taste of unseasoned patties is not the same as an all beef pattie (1, 2). Highly acceptable seasoned beefish patties have been prepared (1, 2, 4). The concept of seasoned beefish mixtures is being developed by concentrating on cured products such as beefish frankfurters (wieners) (2). Initial results have encouraged the U.S. Department of Agriculture to develop new standards for processed meats which will provide for replacing meat with up to 30 percent fish flesh, soy protein, or poultry meat. We understand that Japan and Poland have started to develop similar product applications.

Minced fish might be sold directly to consumers in the form of one or five pound frozen blocks (1). This suggestion includes results from a market survey indicating that a small block could have commercial potential for both retail and institutional trades. From such a consumer sized package, minced fish can be used in an almost endless

[1]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

variety of consumer or institutional recipes such as sauces, salads, soups, and beefish main courses.

Minced fish from fish frames (backbones) or headed and gutted fish may be quick salted by a process which has a high throughput capacity (1). It is based on mixing minced fish with saturated brine and excess salt, then pressing and drying the salted flesh and packaging it. The product is capable of long-term room temperature storage. Its commercial potential may be increased if more uses for minced, salted fish are found.

Mixtures of shellfish meats and minced fish in breaded products appear promising for commercial applications. Some oyster meats may have a low market value due to physical defects such as size or shucking damage. Blends of diced oyster meats with minced fish have resulted in highly acceptable oyster flavored products whose taste can be modified to suit those who may object to the strong flavor of undiluted oysters (2). Small shrimp or shrimp pieces have been mixed with minced fish muscle to produce a shrimp flavored fish portion. In addition to being highly acceptable, it has been reported that the shrimp component improves storage characteristics of the minced fish component (5). Ocean quahog meats are being considered for a similar type of product since they have a robust flavor and a relatively low market value (1).

Meat-bone separators can be used to obtain minced crab meat. Most of this development work has been done by industrial organizations. It is stimulated by a desire to find an economical replacement for handpicking meat from some species or an economical supplement to handpicking for increasing yield of meat from other species. In one study, use of a meat-bone separator was discarded in favor of other equipment which provided larger, more valuable pieces of crab meat (1). If more applications can be developed for minced crab meat such as mixtures with minced fish, crab cakes (1), or seafood patties (6), this application of meat-bone separators may become more popular.

Several laboratories are working on development of new seafood products which are based on minced fish. These products include fish sausages, extruded breaded products, seafood pizza, chowders, beefish items, and products containing textured vegetable protein (1, 2, 4, 6, 7, 8, 9). Some laboratories are studying physical or nutritional properties of minced fish (6, 8, 9, 10).

INFORMATION SOURCES

The subject matter of this communication includes numerous references to unpublished work, about-to-be-published work, and publication in hard-to-find places. Instead of the usual list of references, a list of addresses is provided. If you are interested in learning more about a topic, contact the appropriate address given below.

1) Northeast Utilization Research Center, National Marine Fisheries Service, NOAA, Emerson Avenue, P.O. Box 61, Gloucester, MA 01930.
2) Pacific Utilization Research Center, National Marine Fisheries Service, NOAA, 2725 Montlake Boulevard E., Seattle, WA 98112.
3) Southeast Utilization Research Center, National Marine Fisheries Service, NOAA, Regents Drive, University of Maryland Campus, College Park, MD 20740.
4) Department of Food Science & Technology, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061.
5) Seafoods Laboratory, Oregon State Laboratory, 250 36th Street, Astoria, OR 97103.
6) Seafood Laboratory, Department of Food Science, North Carolina State University, Raleigh, NC 27607.
7) Institute of Food Science & Marketing, Cornell University, Ithaca, NY 14850.
8) Food Science Department, University of Georgia, Athens, GA 30602.
9) Department of Food & Nutritional Science, Univeristy of Rhode Island, Kingston RI 02881.
10) Food Protein R&D Center, Texas A&M University, College Station, TX 77843.

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MFR PAPER 1244

Effects of Cadmium, Mercury, and Silver on Marine Animals

ANTHONY CALABRESE, FREDERICK P. THURBERG, and EDITH GOULD

INTRODUCTION

This summary of recent work at the Milford Laboratory of the National Marine Fisheries Service's Middle Atlantic Coastal Fisheries Center is intended as a convenient reference for scientists investigating heavy-metal stress in marine animals. Increasingly in the past decade, attention has focused on this and related areas of study (for example, Waldichuk, 1973) because of widespread concern over extensive dumping of waste material and runoff of polluted waters into our estuarine, coastal, and oceanic ecosystems. Population growth and technological development are putting serious stress on these areas, and such stress fosters conditions that diminish the harvest of marine resources. The concern is not only for marine animals that are important to commercial and sport fisheries, but also for those animals whose presence indicates a healthy and stable environment.

Information on the nature and degree of man-induced damage to our living marine resources is either fragmentary or lacking. Yet such knowledge is essential for formulating baseline estimates of marine environmental quality, without which resource-oriented water-quality standards cannot be established or enforced by federal and state regulatory agencies.

To establish such standards, it is first necessary to determine how and to what degree pollutants, individually and in combination, affect various marine animals at different life stages. More important than death itself, perhaps, is the damage caused by sublethal concentrations of pollutants. The gradual elimination of an animal species by low levels of pollutants is no less serious than rapid death caused by high levels. Possibly it is even more serious, as low-level effects are less likely to be detected and traced to their source before irreparable damage has occurred.

Numerous studies have been published on the toxicity of heavy metals to aquatic animals, particularly finfish, but these have dealt primarily with freshwater rather than marine species. The National Marine Fisheries Service (NMFS), through the Middle Atlantic Coastal Fisheries Center (MACFC), Milford, Conn., has consequently undertaken research programs designed to generate the basic knowledge required for effective management of the marine environment and its living resources. The New York Bight, which is receiving international attention because of the large amount of waste material it receives, borders the most heavily populated and industrialized area in the United States. Because MACFC is located within this geographical area, it has initiated studies to determine the influence of pollutants on key marine animals within the Bight.

As part of this major effort, the MACFC laboratory has exposed important species of indigenous fishes, mollusks, and crustaceans to cadmium, mercury, and silver to study mortality rates and any physiological and biochemical changes caused by these heavy metals. Tissues of experimentally exposed animals have also been provided to MACFC laboratories at Oxford, Md., and Sandy Hook, N.J., for histopathological and biochemical examination, evaluation of immune response to various antigens, and measurement of metal uptake into various tissues and organs.

This report summarizes the data collected in the course of these studies. No attempt has been made to review the scientific literature, as such material has been covered in papers published previously and cited in this report.

METHODS

Test animals used in these studies were collected from Long Island Sound near Milford, Conn. Prior to heavy-metal exposure, they were acclimated in the laboratory for at least 2 weeks. Exposures were either short-term (hours to days) static tests or long-term (weeks to months) continuous-flow tests. Systems such as shown in Figure 1 were used for static tests, and the modified Mount

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Figure 1.—Exposure system for short-term static tests.

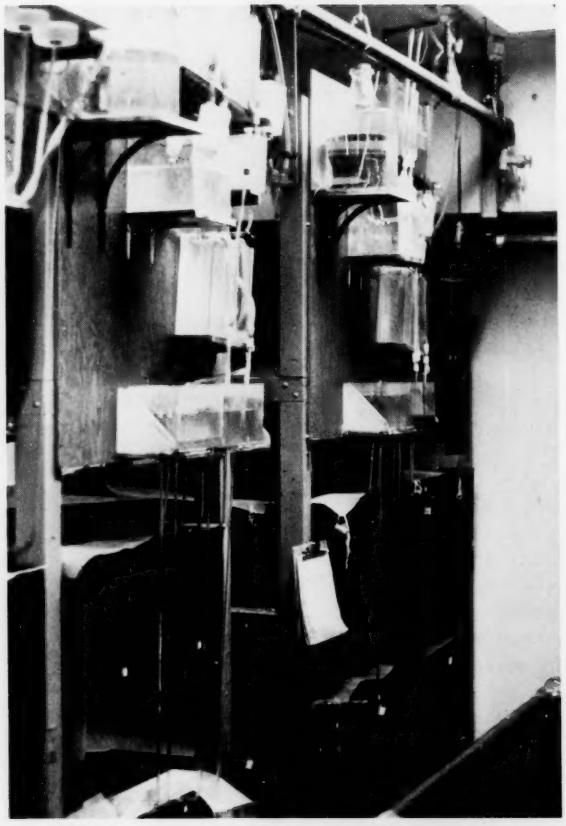

Figure 2.—Exposure system for long-term continuous-flow tests.

and Brungs (1967) proportional dilutor shown in Figure 2, for continuous-flow tests. At the end of each exposure period or at intervals during that time, animals were removed for evalutaion of metal stress.

For studies of inhibited development of bivalve eggs and larvae, modified techniques of Davis and Calabrese (1964) were used. Physiological and biochemical changes in juvenile and adult organisms were measured and evaluated as described by Thurberg et al. (1973), Calabrese et al. (1974, 1975), and Gould (in press). Except where otherwise noted, cadmium and mercuric chlorides and silver nitrate were used throughout.

OBSERVATIONS

Short-term tests were designed not only to measure mortality rates, but also to determine tolerance ranges and discover those metabolic systems most sensitive to metal stress. Long-term tests were designed primarily to study the physiological and biochemical effects of sublethal metal stress. The data are summarized in Tables 1-3 according to the metal used: cadmium, mercury, or silver. For ease of discussion, the following observations are arranged into three major groups: mollusks, crustaceans, and finfish.

Mollusks

Metal exposure tests on mollusks included evaluation of larval and juvenile mortality and oxygen consumption of adult animals. Both short- and long-term exposures were used, and salinity variables were examined.

Embryos of the American oyster, *Crassostrea virginica,* were exposed to mercury, silver, or cadmium and the concentrations that caused 50 percent mortality (LC_{50}) in 48 hours were determined. Mercury and silver were extremely toxic, with LC_{50} values of 5.6 and 5.8 parts per billion (ppb), respectively. Cadmium, on the other hand, had low toxicity with an LC_{50} of 3,800 ppb (Calabrese et al., 1973). Larvae of this same species were exposed to mercury and silver for 12 days; concentrations of these two metals causing 50 percent mortality were 12 and 25 ppb (unpublished data), respectively, indicating that embryos are more sensitive than larvae.

In similar tests, embryos and larvae of the hard clam, *Mercenaria mercenaria,* were exposed to mercury and silver. The LC_{50} values for embryos were 4.8 and 21.0 ppb, and for larvae 14.7 and 32.4 ppb, respectively (Calabrese and Nelson, 1974; unpublished data). A comparison of results with clam and oyster embryos and larvae indicates that clam embryos and larvae are as sensitive to mercury as oyster embryos and larvae, but less sensitive to silver.

Juvenile bay scallops, *Argopecten irradians,* were exposed to mercury, silver, or cadmium for 96 hours. Fifty percent mortality occurred at 33 ppb silver, 89 ppb mercury, and 1,480 ppb cadmium. Although in scallops the order of toxicity for mercury and silver was the reverse of that found for clam and oyster embryos and larvae, these two metals are still far more toxic than cadmium. Juvenile scallops exposed to the LC_5 and LC_{25} values of cadmium for 96 hours, however, had significantly higher oxygen-consumption rates than controls. Scallops exposed to silver at the LC_{25} level also had elevated respiration, whereas those at the LC_5 level respired at a slightly lower rate than controls (Nelson et al., 1976).

Mud snails, *Nassarius obsoletus,* exposed to sublethal concentrations of silver or cadmium, exhibited deviations from normal behavior and had altered oxygen-consumption rates. The oxygen-consumption rate of these snails after exposure to silver was depressed at concentrations greater than 500 ppb and was slightly elevated after exposure to 500-4,000 ppb cadmium (MacInnes and Thurberg, 1973).

A later study was designed to evaluate the sublethal effects of silver on American oyster, hard clam, blue mussel (*Mytilus edulis*), and soft-shell clam, *Mya arenaria,* held at various salinities for 96 hours. Each species respired at a significantly higher rate after exposure to levels of silver as low as 100 ppb. This sensitivity varied with salinity, and certain silver-salinity combinations were lethal (Thurberg et al., 1974). In long-term exposures (30-90 days) to 5 percent (10 ppb), the silver concentration used in the short-term study, these same species also had elevated oxygen-consumption rates. Rapid recovery after removal from the contaminated water is apparently not possible; bivalves placed in "clean" water for 30 days, following 30 days in silver-contaminated water, still had elevated respiration (unpublished data).

A subsequent study involved all three major life stages of the surf clam, *Spisula solidissima*. Larvae exposed to 50 ppb silver for 2-15 days respired at a rate higher than the controls. Juvenile clams exposed to silver for 96 hours had elevated respiration at 10 ppb, but not at 5 ppb. Adults exposed for 96 hours had higher respiration rates than controls at 50 and 100 ppb, but not at 10 ppb. Valve-movement studies conducted on adult clams showed more rapid rhythmic activity in exposed clams than in control animals. There was rapid accumulation of silver in gill and body tissues, with gills concentrating four times as much silver as other tissues (Thurberg et al., 1975).

Crustaceans

Different species of decapod crústaceans showed the same diversity of physiological response to metal exposure as did the mollusks. We looked at the salinity variable again, as well as different salts of mercury and cadmium.

Toxicity of cadmium during short-term (72 hours) exposure of mud crabs, *Eurypanopeus depressus,* was measured by mortality and oxygen-consumption rates (Collier et al., 1973): LC_{50} was 4,900 ppb and LC_{100}, 11,000 ppb. Gill-tissue oxygen consumption was depressed with increasing cadmium concentration.

Green crabs, *Carcinus maenas,* and rock crabs, *Cancer irroratus,* were exposed for 48 hours to various concentrations of cadmium chloride at five different salinities (Thurberg et al., 1973). Cadmium elevated blood-serum osmolality of green crabs, but not that of rock crabs, and oxygen consumption was depressed in both species. Concentrations of 2,000 ppb and higher were lethal to rock crabs, whereas green crabs survived at 4,000 ppb.

In further experimentation with rock crabs, effects of cadmium chloride and cadmium nitrate were compared. A difference in effect was found in short-term (96 hours) and long-term (30 days) exposure series, although these effects were strongest in the acute studies (Gould et al., 1976). A key enzyme of nitrogen metabolism, aspartate aminotransferase (AAT), also important in energy mobilization in invertebrates, was used as the biochemical index of stress. Throughout these studies, AAT was consistently elevated in crabs exposed to cadmium chloride, but not to cadmium nitrate. More mortalities occurred in the chloride groups and, in short-term studies, serum magnesium was elevated in crabs exposed to the chloride salt, but not in those exposed to the nitrate salt. In long-term studies, blood-serum osmolality was raised in the chloride, but not in the nitrate groups.

Sublethal effects of cadmium, mercury, and silver were evaluated in the American lobster, *Homarus americanus*. Cadmium induced greater physiological and biochemical changes than mercury, although uptake of mercury into various tissues was ten times greater than cadmium. Gill tissue from cadmium-exposed (3-6 ppb) lobsters had elevated rates of oxygen consumption and showed some signs of increased ATPase activity (Thurberg et al., in press). In antennal glands, ligand sensitivity was lost in a key regulatory enzyme of the pentose phosphate shunt, glucose-6-phosphate dehydrogenase (G6PdH). In the heart, magnesium sensitivity was lower in transaminase and activity increased, both in a metalloenzyme, lactic dehydrogenase (LdH), and in glycolytic enzymes involved in the mobilization of energy, glucose-phosphate isomerase (GPI) and pyruvate kinase (PK) (unpublished data). Chronic exposure to mercury (6 ppb) produced a lesser effect on ligand sensitivity of heart transaminase than cadmium exposure, and none at all on gill-tissue respiration. Neither cadmium nor mercury affected serum osmolality, and very little difference was found in any test when data from 30- and 60-day exposures were compared (Thurberg et al., in press).

In a comparison of mercuric chloride and mercuric nitrate, again for 30 days at sublethal concentrations (6 ppb), the chloride salt proved to be more toxic. Ligand sensitivity of G6PdH decreased in the antennal glands of chloride-exposed lobsters, but not in the nitrate group; in the heart muscle of the chloride group, activity increased, both in the metalloenzyme LdH and in the glycolytic enzymes GPI and PK, but not in the nitrate group; and in female gonads, glycolysis increased in the chloride, but not in the nitrate group. Neither gill-tissue oxygen consumption nor serum osmolality changed in lobsters exposed to either of the mercuric salts. In lobsters exposed under like conditions to silver nitrate, the biochemical pattern was similar to that observed in the mercuric chloride-exposed animals, but to a much lesser degree. Again, neither gill-tissue respiration nor serum osmolality changed. Heart transaminase was depressed in silver-exposed lobsters, however, as in cadmium-exposed rock crabs, but not in cadmium- or mercury-exposed lobsters. The order of metal toxicity for adult lobsters, therefore, as determined by these biochemical parameters, is $CdCl_2 > HgCl_2 > AgNO_3 > Hg(NO_3)_2$ (unpublished data).

Finfish

We have thus far examined three teleost species after exposure to metals: the cunner, *Tautogolabrus adspersus,* winter flounder, *Pseudopleuronectes americanus,* and striped bass, *Morone saxatilis;* and similar work with the coho salmon, *Oncorhynchus kisutch,* is presently under way.

In a short-term study (96 hours) of cadmium-exposed cunners, high levels (48,000 ppb) of this metal produced abnormally high serum osmolalities, and only 3,000 ppb Cd reduced the normal rate of gill-tissue oxygen consumption (Thurberg and Dawson, 1974). These indicators of stress are probably related to tissue damage as observed in concurrent histopathological and immunochemical studies on the same fish (Newman and MacLean, 1974; Robohm and Nitkowski, 1974). Cadmium uptake averaged 8.5 times higher in livers than in gills (Greig et al., 1974). Biochemical data for two liver enzymes showed significant changes in fish exposed to 24,000 ppb Cd. Transaminase activity was depressed, and a magnesium-linked enzyme required 10 times as much added magnesium to reach the same level of activity as in the control fish (Gould and Karolus, 1974). The latter observation was the first to point to metal-induced suppression of a specific metabolic control.

Another short-term study (96 hours) with cunners compared the effects of silver nitrate and silver acetate at 1,000 ppb Ag. Gill-tissue respiration was depressed by both salts, with no significant difference in their effects (Thurberg and Collier, in press; Gould and MacInnes, in press). Biochemical changes induced by exposure to silver, however, did differ significantly with the salt form. Liver transaminase was higher in fish exposed to the acetate salt than in those exposed to the nitrate salt, and shunt activity (G6PdH) in the liver was significantly depressed in the nitrate group, but not in the acetate group (Gould and MacInnes, in press).

In chronic exposures (30-60 days) of cunners to cadmium chloride, 100 ppb Cd depressed oxygen-consumption rates of gill tissue, as in the acute study, and changes were also observed in liver transaminase and G6PdH activities (MacInnes et al., 1977). Long-term exposure to mercury, on the other hand, elevated gill-tissue respiration (unpublished data).

Chronic exposures (30-90 days) of juvenile striped bass to very low levels of either cadmium (0.5-5 ppb) or mercuric (1-10 ppb) chloride depressed gill-tissue respiration, but induced no significant change in either of two liver enzymes monitored (Dawson et al., in press).

Chronic exposures (60 days) of winter flounder to cadmium chloride, to mercuric chloride, and to silver nitrate produced some contrasting data. At 10 ppb, cadmium depressed gill-tissue respiration, whereas 10 ppb Hg increased it and, although cadmium provoked no significant hematological response, mercury induced differences in plasma protein levels, osmolality, hematocrit, hemoglobin, and mean corpuscular hemoglobin (Calabrese et al., 1975). Silver caused no detectable change either in gill-tissue respiration or in hematological indices (unpublished data). There was no significant cadmium uptake in tissues of exposed fish, but considerable mercury accumulated in tissues of fish exposed to that metal (Calabrese et al., 1975). Biochemical data pointed to cadmium as the most toxic to adult flounder of the three metals tested, with mercury second and silver least effective. In the kidney and hematopoietic tissue of cadmium-exposed (10 ppb) fish, metalloenzyme activity increased and the regulatory shunt enzyme G6PdH lost sensitivity to the positive-modulating effect of magnesium (Gould, in press). Ligand sensitivity was also lowered in some heart enzymes; enzyme induction occurred in heart, gonad, and skeletal muscle and in the liver, glycolysis and shunt activity increased (unpublished data). In the mercury-exposed (10 ppb) flounder, the same phenomena were observed, but to a considerably lesser extent; and in silver-exposed fish, there was very little effect (unpublished data). Thus the order of metal toxicity for adult winter flounder appears to be the same as that observed for adult lobsters, $CdCl_2 > HgCl_2 > AgNO_3$.

DISCUSSION

Tables 1-3 capsulize the results of the various experimental series performed with cadmium, mercury, and silver, using marine animals selected as important to and representative of the New York Bight. The most obvious generalization is that both the order and degree of metal toxicity vary, not only with such parameters as salinity and metal salt form, but also with life stage and species. No other overall conclusion can be drawn at this point.

A few emerging patterns, however, may be seen in the data thus far. For example, early life stages appear to be more sensitive to mercury and silver than cadmium; this is true of the mollusks tested, and work with juvenile lobsters confirms this pattern (unpublished data). Other marine larval forms have been reported to have this same order of sensitivity (Waldichuk, 1974). Another consistent finding has been that mercury and silver are taken up very readily by tissues of juvenile and adult animals, whereas cadmium is taken up to a far lesser degree. The difference in uptake rates may account at least in part for the relative toxicities of these three metals in the rapidly metabolizing early life forms. The greater the body burden of metal, it seems, the greater the toxicity. Paradoxically, however, the order of toxicity in adult animals is reversed from that observed in juvenile stages, with cadmium producing more severe effects than either mercury or silver, despite the much lower rate of cadmium uptake. The adult animals examined had apparently acquired a relative tolerance for mercury and silver—perhaps a sequestering mechanism—that is lacking in juvenile forms and which enables their metabolism to function even with large body burdens of these metals.

One tentative observation arises from the work with finfish thus far. Striped bass, a marine species that moves to brackish or fresh water to spawn, adapted to long-term metal exposure with little sign of stress, in marked contrast to winter flounders and cunners. Current work with coho salmon, too, shows it to be remarkably stress-free after long-term cadmium exposure (60 days and 100 ppb). The relative metal tolerance of these two anadromous species points to a metabolism capable of adapting readily to environmental change.

Sprague (1971) has stated that "Understanding physiological action of a toxicant is the key to predicting important sublethal effects." Examination of tissues from metal-exposed crustaceans and finfish has revealed two general and basic effects of sublethal metal challenge. The first is the induction of enzymes that are either directly attacked (metalloenzymes) or involved in the mobilization of energy (glycolysis) or in

Table 1.—Cadmium—Effect on marine animals.

Organism	Exposure period	Concentration (ppb)	Oxygen consumption	Osmoregulation	Enzyme activity	Other
Crassostrea virginica American oyster (eggs)	48 hr					LC_{50} × 3,800 ppb (2)[1]
Argopecten irradians Bay scallop (juveniles)	96 hr	940	Elevated (16)			LC_{50} = 1,480 ppb; significant Cd uptake (16)
Nassarius obsoletus Mud snail	72 hr	500	Elevated (13)			Distressed behavior (13)
Carcinus maenas Green crab	48 hr	500	Depressed (25)	Disruption (25)		
Cancer irroratus Rock crab	48 hr	120	Depressed (25)	No effect (25)		
	96 hr	1,000			Chloride salt increased transaminase, nitrate salt no effect (heart) (9)	Serum Mg unchanged (9)
	30 days	250	Depressed (u)		Chloride salt increased transaminase, nitrate salt no effect (heart) (u)	Serum Mg unchanged (u)[2]
Eurypanopeus depressus Mud crab	72 hr	4,000	Depressed (5)			LC_{50} = 4,900 ppb; LC_{100} = 11,000 ppb (5)
Homarus americanus American lobster	30 days	3-6	Elevated (22)	No effect (22)	Enzyme induction, lowered ligand sensitivity (heart, antennal gland) (22, u)	
	60 days	3-6	Elevated (22)	No effect (22)		Significant Cd uptake in gills (22)
Tautogolabrus adspersus Cunner	96 hr	3,000-48,000	Depressed (24)	Disruption (24)	Depressed transaminase, lowered ligand sensitivity (liver) (10)	Some histopathological effects (17); liver uptake 8.5 times greater than gills (12)
	30 days	50-100	Depressed (14)	No effect (14)	Depressed transaminase, higher shunt activity (liver) (14)	
	60 days	50	Depressed (14)	No effect (14)		
Morone saxatilis Striped bass	30 days	0.5-5.0	Depressed (7)		No effect (liver, skeletal muscle) (7)	
	90 days	5	No significant effect (7)		No effect (liver, skeletal muscle) (7)	90-day exposure and 30-day clearance; depressed transaminase and shunt activity (liver) (7)
Pseudopleuronectes americanus Winter flounder	60 days	5-10	Depressed (4)		Enzyme induction, lowered ligand sensitivity (heart, kidney, gonad, skeletal muscle) (8, u)	No detectable Cd uptake in blood or gills. No hematological or histopathological changes (4)
	150 days	10			Increased glycolysis and shunt activity, lowered ligand sensitivity (kidney, liver) (u)	

[1]Numbers in parentheses refer to citations in Literature Cited.
[2]u means unpublished.

the production of metabolites for biosynthesis (pentose shunt), and chronic demand for enzyme production is costly in terms of metabolic energy. The second effect, the loss of ligand sensitivity, by which enzyme reaction rates are regulated, is perhaps more serious. Even partial blocking of such physiological controls is a lessening of the metabolic flexibility necessary for an animal's adaptation and survival during environmental challenge, whether natural or anthropogenic.

Implications for recruitment to fish stocks should not be lightly dismissed. Heavy-metal pollution is greatest in our estuarine and inshore coastal waters. These highly polluted areas are the breeding grounds and nurseries for many marine species important to both commercial and sport fisheries, stocks whose contemplated management now engages our most earnest attention.

Marine scientists have only begun to explore the effects of this class of pollutant. It is necessary to proceed from the initial studies of individual metals to studies of synergistic effects, not only of metals combined with other metals and salt forms, but also of metals combined with other environmental challenges, whether issued by man or by nature. World-wide concern with marine pollution and its effects, manifested in international study groups and symposia, underscores the need for understanding the nature of such multiple stress.

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Table 2.—Mercury—Effect on marine animals.

Organism	Exposure period	Concentration (ppb)	Oxygen consumption	Osmoregulation	Enzyme activity	Other
Crassostrea virginica American oyster						
(eggs)	48 hr					LC_{50} = 5.6 ppb (2)[1]
(larvae)	12 days					LC_{50} = 12.0 ppb (u)[2]
Mercenaria mercenaria Hard clam						
(eggs)	48 hr					LC_{50} = 4.8 ppb (3)
(larvae)	10 days					LC_{50} = 14.7 ppb (u)
Argopecten irradians (juveniles) Bay scallop	96 hr					LC_{50} = 89.0 ppb; significant Hg uptake (16)
Homarus americanus American lobster	30 days	6	No effect (22)	No effect (22)	Some enzyme induction, some loss of ligand sensitivity with chloride salt; no effect with nitrate salt (heart, antennal gland, gonad) (22, u)	Significant Hg uptake in digestive gland, gills and tail muscle (22)
	60 days	6	No effect (22)	No effect (22)		
Tautogolabrus adspersus Cunner	30 days	5	Elevated (u)			
Morone saxatilis Striped bass	30 days	5	Depressed (7)		No effect (liver) (7)	
	60 days	10	Depressed (7)		No effect (liver) (7)	
	90 days	10	No significant effect (7)		No effect (liver) (7)	
Pseudopleuronectes americanus Winter flounder	60 days	5-10	Elevated (4)		Some enzyme induction, some loss of ligand sensitivity, increased shunt activity (kidney, liver, heart, gonad) (8)	Some blood changes; Hg uptake in blood and gills (4)

[1]Numbers in parentheses refer to citations in Literature Cited.
[2]u means unpublished.

Table 3.—Silver—Effect on marine animals.

Organism	Exposure period	Concentration (ppb)	Oxygen consumption	Osmoregulation	Enzyme activity	Other
Crassostrea virginica American oyster						
(eggs)	48 hr					LC_{50} = 5.8 ppb (2)[1]
(larvae)	12 days					LC_{50} = 25.0 ppb (u)[2]
	96 hr	100	Elevated (21)			Ag uptake by gills (21)
Mercenaria mercenaria Hard clam						
(eggs)	48 hr					LC_{50} = 21.0 ppb (3)
(larvae)	10 days					LC_{50} = 32.4 ppb (u)
	96 hr	100	Elevated (21)			Ag uptake by gills (21)
Argopecten irradians Bay scallop						
(juveniles)	96 hr	22	Elevated (16)			LC_{50} = 33.0 ppb; significant Ag uptake (16)
Spisula solidissima Surf clam						
(larvae)	2-15 days	50	Elevated (20)			
(juveniles)	96 hr	10	Elevated (20)			100 ppb lethal (20)
	96 hr	50	Elevated (20)			Increased valve movement; Ag uptake by gills (20)
Mytilus edulis Blue mussel	96 hr	100	Elevated (21)			Ag uptake by gills (21)
Mya arenaria Soft-shell clam	96 hr	100	Elevated (21)			Ag uptake by gills (21)
C. virginica, M. mercenaria, M. edulis, Placopecten magellanicus	30, 60, 90 days	10	Elevated (u)			
Nassarius obsoletus Mud snail	72 hr	500	Depressed (13)			Distressed behavior (13)
Homarus americanus American lobster	30 days	6	No effect (u)	No effect (u)	Depressed transaminase (heart), some loss of ligand sensitivity (antennal gland), enzyme induction (gonad); all effects small (u)	
Tautogolabrus adspersus Cunner	96 hr	120-500	Depressed (23)	No effect (23)	Depressed shunt activity (liver), changed ligand sensitivity (skeletal muscle) (11)	
Pseudopleuronectes americanus Winter flounder	60 days	10	No effect (u)		Depressed transaminase (liver), very little effect (kidney, heart, gonad) (u)	

[1]Numbers in parentheses refer to citations in Literature Cited.
[2]u means unpublished.

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MFR PAPER 1245

Fishery Engineering Advancements: A 5-Year SEFC Progress Report

THOMAS M. VANSELOUS

ABSTRACT–The Southeast Fisheries Center of the National Marine Fisheries Service, NOAA, formally established the Technology Division in 1973 to apply and monitor technological advancements, and to develop new methods and increase the accuracy and efficiency of old methods for assessment and utilization of living marine resources.

Two groups comprise the Technology Division: Harvesting Technology and the Fisheries Engineering Laboratory. A summary of activities undertaken by the Division is contained in this report. These activities are Satellite Application, Remote Sensing, Sampling and Analysis Systems, Harvesting Technology and Conservation Engineering, Data Management, and Planning and Systems Analysis.

INTRODUCTION

Man's increasingly diversified use of the oceans, coupled with the complexity and vastness of marine ecosystems, dictates the need for technological advancements to accelerate the collecting, processing, and managing of resource assessment information required to make intelligent fisheries management decisions. Therefore, the Southeast Fisheries Center (SEFC) of the National Marine Fisheries Service (NMFS), NOAA, established a Fisheries Engineering Program in 1971 to provide the emphasis necessary to fulfill these needs.

In 1973, an SEFC reorganization established the Technology Division, composed of existing engineering elements located at the Fisheries Engineering Laboratory (FEL), Bay Saint Louis, Miss., and the Pascagoula Fisheries Laboratory, Pascagoula, Miss. This document is a compilation of the various projects undertaken by these elements over the past 5 years.

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Missions and Objectives

NMFS has a well-established program of biological sampling and research; however, sufficient engineering capability has not always been available to apply engineering talents and principles to fishery problems when technology was found to be a major constraint to achieving NMFS goals. The mission of the Technology Division is to satisfy the technological needs of the other SEFC Divisions; promote technological advancements in fisheries management and utilization; and apply engineering expertise to fishery problems when technology is found to be a major constraint to achieving NMFS goals. The mission is being implemented through three organizational objectives: 1) Development of sampling, monitoring, and tracking systems to increase data return, coverage, and accuracy; 2) development of fishing gear and tactics to efficiently harvest latent and underutilized fishery resources, conserve nontarget species, and reduce damage to marine habitats; and 3) development of data management systems and techniques for efficient data storage, retrieval, display, and analysis.

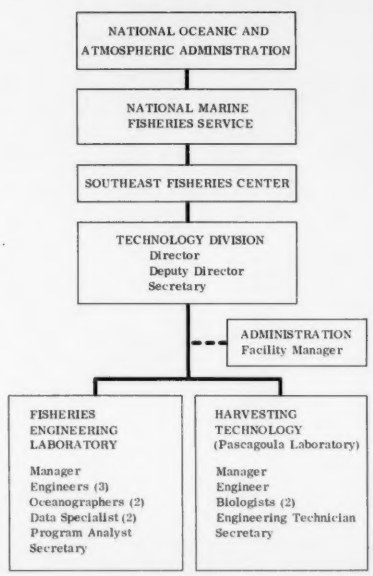
Organizational Structure

The organizational structure of the Technology Division (Fig. 1) consists of four elements: Management, administration, FEL, and Harvesting Technology. Management establishes policies, procedures, and new program areas, and maintains liaison with SEFC, other NMFS organizational elements, and other agencies. Administration includes functions such as facility management, personnel, and purchasing. The FEL is responsible for aerospace remote sensing applications, systems analysis, and data management functions. Harvesting Technology deals with underwater remote sensing, conservation engineering, and harvesting systems. Both elements are active in technology transfer to, and applications engineering for, affected user groups.

Management Concept

A project engineer is assigned to each discrete element of work. It is his responsibility to conduct that effort in a semiautonomous manner drawing on associates with special skills as required.

Figure 1.—Technology Division organizational structure.



Managers oversee and coordinate all activities. Periodic program reviews and regular staff meetings are used to keep management apprised.

Interagency Involvement

Most of the Technology Division is located at NASA's National Space Technology Laboratory (NSTL), Bay Saint Louis, Miss. The objective of NSTL is the application of technology in space and environmental sciences. These applications are stimulated by the catalytic effect of a multiagency operation sharing, interchanging, and utilizing individual research developments to enhance the entire NSTL technical and scientific community. Agencies colocated at NSTL include elements of NASA, NOAA, and EPA; the Departments of Interior, Transportation, and Defense; and Mississippi and Louisiana State governments and universities.

Work Breakdown

Activities have been categorized into the following work elements: Satellite Applications, Remote Sensing, Sampling and Analysis Systems, Harvesting Technology and Conservation Engineering, Data Management, and Planning and Systems Analysis. Each is discussed briefly in the following sections. One other element—Technology Transfer and Engineering Applications—provides an effective means to enable the transfer of appropriate technology to interested user groups. As such, this element is the vehicle for disseminating results of all the other work elements.

SATELLITE APPLICATIONS

Existing satellite-supported sensor systems, available for fishery applications, lack sufficient resolution for direct fish detection. However, the use of satellite sensors to measure selected oceanographic parameters and then use these measurements to predict the distribution and abundance of a fish species appears to be feasible (Vanselous and Kemmerer[1]). Two satellite investigations demonstrating this feasibility, the ERTS-1 Menhaden Investigation and the Skylab Gamefish Investigation, have been conducted by FEL. A third—the LANDSAT Menhaden and Thread Herring Investigation—is currently being conducted.

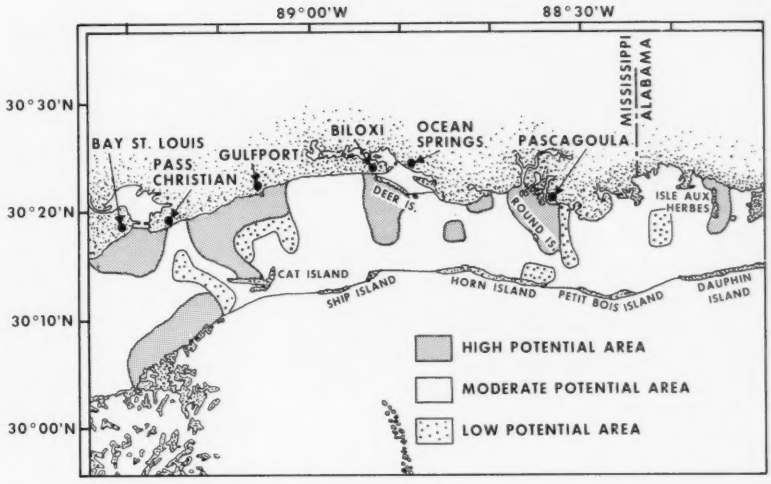


Figure 2.—Predictions for menhaden distribution in the Mississippi Sound on 7 August 1972. (Kemmerer et al., 1974.)

ERTS-1 Menhaden Investigation

The primary objective of the ERTS-1 Menhaden Investigation was to establish the feasibility of using satellite imagery for determining the abundance and distribution of adult menhaden, *Brevoortia patronus*, in the Mississippi Sound. The investigation began in July 1972 and lasted 18 months. Experimental rationale was to convert data obtained by ERTS-1 and aircraft-supported sensors into oceanographic data, derive statistically valid correlations between these data and the distribution and abundance of menhaden, and then determine if the relationships had meaning for commercial fishing operations and resource management.

Participating with NMFS in the experiment were the National Aeronautics and Space Administration (NASA) Earth Resources Laboratory and the National Fish Meal and Oil Association (NFMOA) through its contractor, EarthSat Corporation. NASA's role was to infer a series of oceanographic measurements from remotely sensed data; the NMFS responsibility was to convert these data into fish distribution and abundance information; and the NFMOA function was to develop utilization criteria for the fish distribution and abundance information.

The feasibility of using satellite-supported sensors to predict fish distribution was demonstrated (Kemmerer et al., 1974). ERTS-1 Multispectral Scanner imagery contained density levels which correlated with menhaden distribution. Further, these density levels correlated significantly with sea-truth measurements of Secchi disc transparency and water depth, two parameters which correlated significantly with menhaden distribution. Additionally, surface salinity, Forel-Ule color and chlorophyll-*a* content correlated with menhaden distribution.

A regression model was constructed to predict menhaden distribution in high, moderate, and low-potential categories, reflecting the probability of finding fish at certain points within the study area (Fig. 2). The model was devised empirically using sea-truth measurements of salinity, turbidity, water color, and water depth. These parameters, except depth, can be measured remotely; thus, the model appears to provide a potential tool for using satellite data for enhancing the harvest and management of menhaden.

[1]Vanselous, T. M., and A. J. Kemmerer. An overview of remote sensing applications to fisheries related problems. Proc. Symp. Util. Remote Sensing Data Southeast. U.S. Am. Soc. Photogramm., Athens, Ga., Jan. 1975, 12 p. Unpubl. rep.

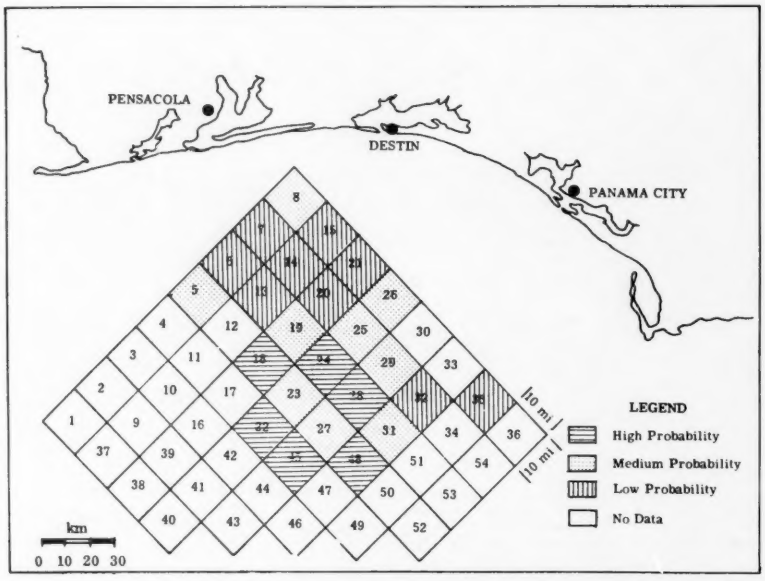


Figure 3.—Prediction results of 4 August data for white marlin. (Savastano et al., see footnote 2.)

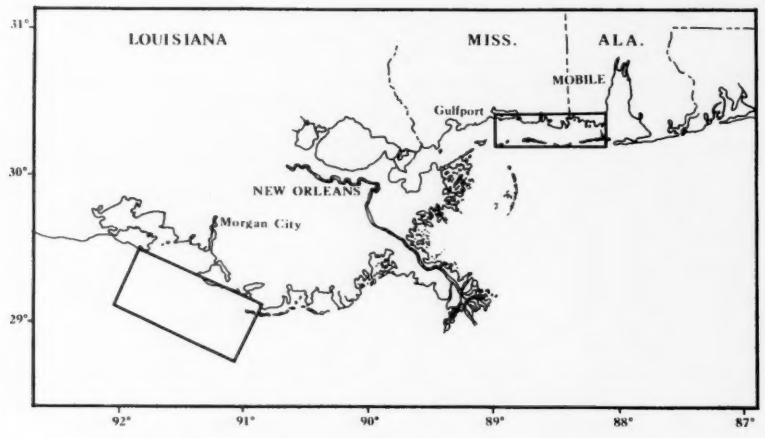


Figure 4.—LANDSAT Menhaden and Thread Herring Investigation test areas.

Skylab-3 Gamefish Investigation

A Skylab-3 experiment was initiated in April 1973 to establish the feasibility of utilizing remotely sensed data acquired from aircraft and satellite platforms to assess and monitor the distribution of oceanic gamefish. The test area was off Florida between Pensacola and Panama City in the northern Gulf of Mexico.

Gulf coast sportfishing clubs, NASA, and NMFS participated in the experiment. The experimental rationale was to establish correlations between selected oceanographic parameters measured remotely, and the fishing success experienced by participating anglers over a 2-day period. Several species known to be in the test area were initially selected as targets for the sportfishermen; however, analytical emphasis was given to white marlin, *Tetrapturus albidus*, because they provided the largest proportion of the sportsmen's catch.

The distribution of white marlin was demonstrated to be significantly correlated with chlorophyll-*a*, sea surface temperature, turbidity, and water density (Savastano et al.[2]). A predictive model for white marlin was developed (Fig. 3) based on these parameters which demonstrated a potential for increasing the probability of gamefishing success.

LANDSAT Menhaden and Thread Herring Investigation

As a logical progression to the previous experiments, a LANDSAT Menhaden and Thread Herring Investigation was initiated in April 1975. Its experimental design is based on the rationale used in the preceding investigations. The primary goal is to verify and refine the relationships of certain coastal and environmental parameters, observable from aerospace platforms, to the availability and distribution of Gulf menhaden. A secondary objective is to establish similar relationships for a potential commercial fish—thread herring, *Opisthonema oglinum*. As in the ERTS-1 Menhaden Investigation, primary participants are NMFS, NASA, and NFMOA.

Two test sites were selected (Fig. 4)—one in the Mississippi Sound and one south of Morgan City, La. The Mississippi Sound was the site of the previous ERTS-1 experiment, which left some questions unanswered. It was not clear whether density differences in satellite imagery, which correlated with fish distribution, represented turbidity or depth relationships. Additionally, sea-truth data appeared at times to be contaminated by maneuvering fishing vessels that produced plumes of turbidity, thereby possibly affecting the analyses. The second site, south of Morgan City, supports sizeable populations of both menhaden and thread herring and is an area of transition between estuarine and oceanic hydrologic zones.

Field operations were completed in September 1975. Primary data acquisition platforms included fishing vessels (with and without scientific observers aboard), oceanographic vessels, spotter aircraft, NASA low- and medium-altitude aircraft, and photographic aircraft. LANDSAT-1 and -2 provided satellite coverage of the test areas. Most sea-truth data have been formatted and stored on magnetic tape. Data analyses and conclusions are scheduled to be completed in early 1977.

[2]Savastano, K. J., E. J. Pastula, Jr., E. G. Woods, and K. J. Faller. Preliminary results of fisheries investigation associated with Skylab-3. Ninth Int. Symp. Remote Sensing Environ., Environ. Res. Inst. Mich., Apr. 1974, 30 p. Unpubl. rep.

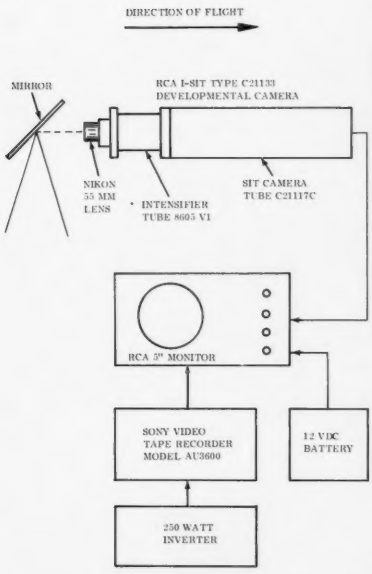


Figure 5.—Low-light-level television system block diagram. Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

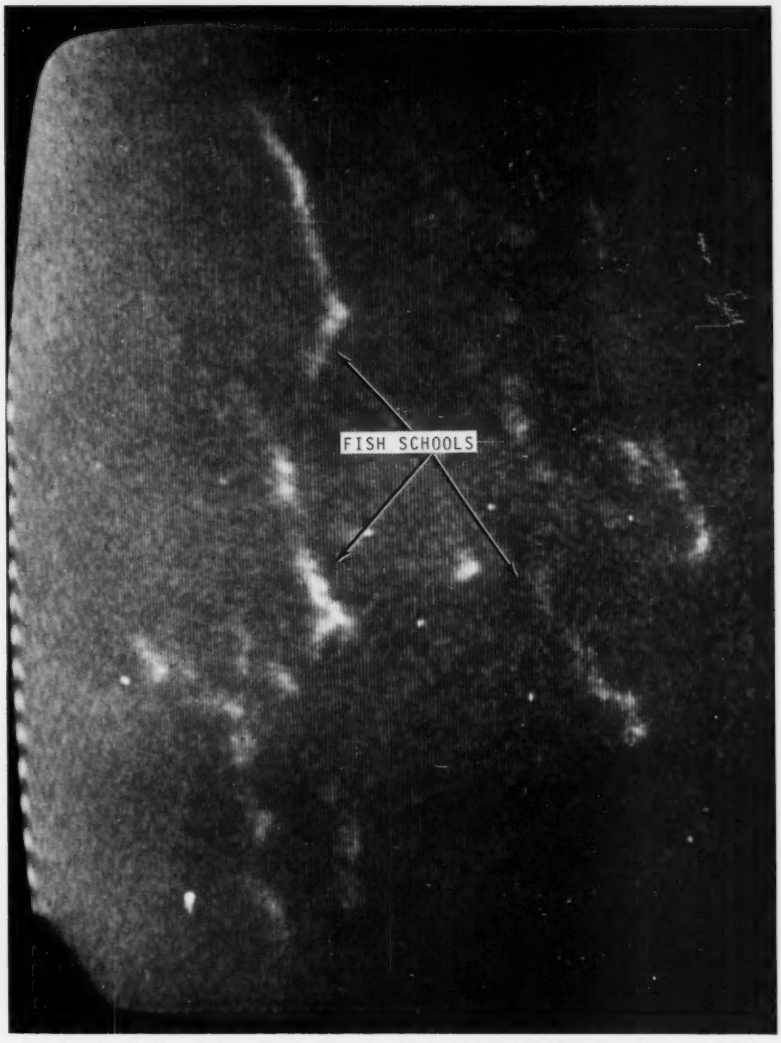


Figure 6.—Low-light-level television system video data showing schools of menhaden from 914.4 meters (3,000 feet).

Brazilian Shrimp Investigation

In support of the U.S.-Brazil Agreement of 9 May 1972 a preliminary study was implemented to ascertain if a relationship existed between the distribution of shrimp and a relatively constant high-turbidity zone along the northeast coast of South America. Using LANDSAT imagery, the study showed that the shrimp grounds could be divided into general regions of primary and secondary turbidity. The stratification of the turbidity patterns was found to be similar to the distribution of the shrimp fishery located off the coasts of Guyana, Surinam, and French Guiana. The four species of shrimp found in the area are distributed in distinct bands generally parallel to the coastline. Not only were the bands of shrimp distribution similar in orientation and shape to the primary and secondary turbidity region, but also the entire shrimp fishery was located within the general seaward limits of the turbidity region. A more comprehensive study has been proposed to further delineate the shrimp/turbidity relationship.

REMOTE SENSING

The objective of this program is to develop remote sensing systems to efficiently locate, identify, and quantify living marine resources. Two approaches are being investigated—airborne remote sensors, and surface and subsurface sensing systems. Airborne sensors are limited to the detection of epipelagic fishes and surface oceanographic phenomena which may influence pelagic and demersal species. Surface and subsurface sensors can provide valuable information about mid-water and benthic fishes and crustaceans, and related environmental parameters.

Low-Light-Level Television

The phenomenon of bioluminescence and the development of tactical night vision devices for the military in Vietnam led to an investigation of the applicability of low-light sensors for detection of fish schools. A number of system components have been tested and evaluated. The system currently used (Fig. 5) consists of a television camera fitted with an intensifier tube that amplifies light approximately 120,000 times, a 12.7-cm (5-inch) television monitor, a video tape recorder, and a power source. The system is used from aircraft operating at night during dark-of-the-moon periods. It detects and amplifies the bioluminescence caused by fish agitating dinoflagellates (very small plankton) in the water. The effect is a faint glow surrounding each fish and, in turn, the fish school. This glow can be easily observed with the low-light-level television (Fig. 6).

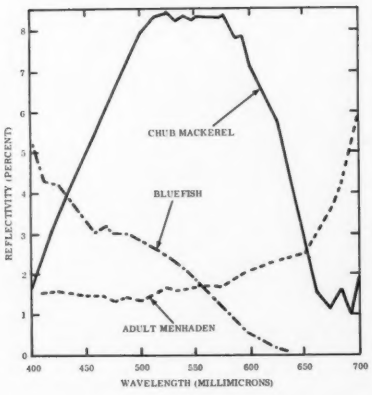


Figure 7.—Spectral signatures of three species of pelagic fishes.

Figure 8.—Photographic imagery showing Atlantic bluefin tuna.

The system has been used in a developmental mode to survey saury, *Cololabis saira,* northern anchovy, *Engraulis mordax,* and euphasiid shrimp schools in the Pacific Northwest; menhaden, *Brevoortia patronus,* and thread herring, *Opisthonema oglinum,* in the northern Gulf of Mexico; Atlantic herring, *Clupea harengus harengus,* off the northern coast of Scotland; bluefin tuna, *Thunnus thynnus,* off the New England and Florida coasts; and pilchard, *Sardinops ocellata,* off the coast of South Africa.

Aerial Photography

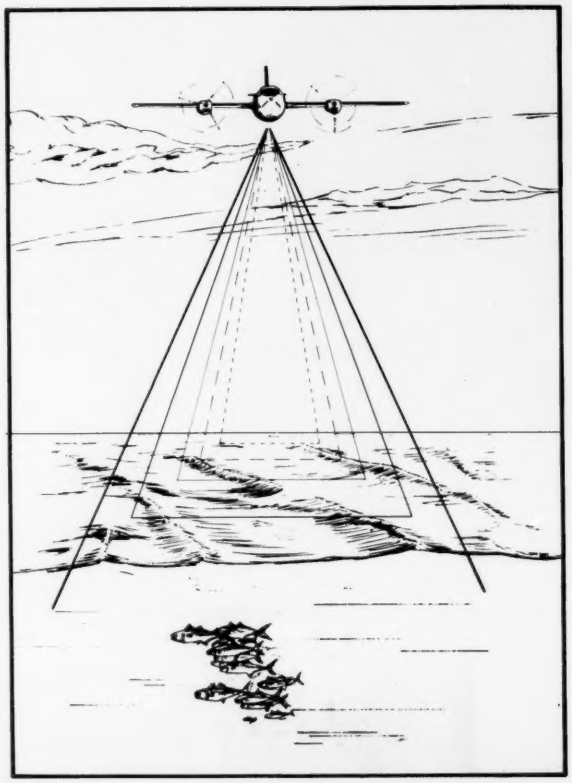
Aerial photography is probably used more than any other remote sensing technique for direct detection of selected species of fish and marine mammals. A standard aerial mapping camera equipped with a 22.9-cm (9-inch) film format, and 15.2-cm (6-inch) or 30.5-cm (12-inch) focal length lens is commonly used.

Many pelagic species exhibit unique spectral signatures which can be used to assist in the photographic identification and discrimination of fish against the light-absorbing water background. Bluefish, *Pomatomus saltatrix,* reflect highly in the blue portion of the spectrum (400-500 mμ), chub mackerel, *Scomber japonicus,* in the yellow-green portion (500-600 mμ), and menhaden, *Brevoortia* sp, in the red portion (600-700 mμ) (Fig. 7). Enhancement of these color differences through proper selection of film and filters produce contrasting fish school images (Fig. 8).

Laser

Airborne laser systems (Fig. 9) are being investigated as a possible future method of fish assessment. They have the potential of

Figure 9.—Laser system survey pattern. (Woods, E. G. Recent developments in remote sensing technology for marine resource detection and monitoring. 62nd Statutory Meeting. International Council for the Exploration of the Sea, Copenhagen, Denmark, Sep.-Oct. 1974, 12 p. Unpubl. rep.)



being used during day and night, and acquiring data from significant depths. Nominal objectives of the developmental effort are detection, identification, and quantification of fish schools at various depths in the water column.

Application of laser technology to fish detection has received little attention to date, probably because laser systems were not sufficiently developed for airborne operations. Recent developments in laser technology, however, have increased the probability of developing a suitable laser survey system. A feasibility study was initiated in 1973 as the first step in laser application. Objectives of the study were to determine the feasibility of using lasers for detecting fish, and to generate a model defining the physical characteristics of laser light as it penetrates the water column, strikes a target, and returns to a suitable detector. Murphree et al. (1974) reported that the air-sea interface would permit entry of sufficient signal and return of meaningful fisheries information. This conclusion was based on perpendicular signal penetration. The effect of laser scanning and noise in the resulting signal are being investigated in a follow-on study.

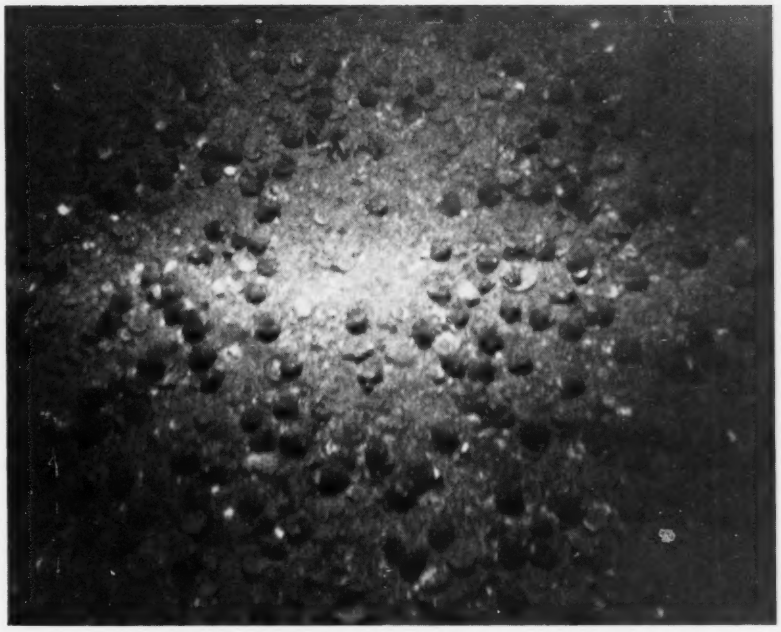


Figure 10.—Dense calico scallop concentration photographed by RUFAS I.

Spectrometer

Spectrometer investigations were initiated in 1968 to establish the feasibility of using various portions of the visible light spectrum for locating and identifying epipelagic fishes. Spectral systems were expected to record color and intensity of the reflection of the sun's rays off fish schools. These data were counted on to yield information on the location, identification, and biomass of epipelagic fish schools.

Initial tests were conducted in a laboratory environment where anesthetized fish were placed in a spectrometer's field of view and the spectral signatures recorded. Other tests used live fish schools impounded in nets below an offshore platform near Panama City, Fla., and in a tank system developed by FEL. Airborne tests were also conducted in the northern Gulf of Mexico and off the coast of southern California in conjunction with sea-truth fishing operations.

Analyses of test data revealed that while many fish exhibited unique spectral signatures, these signatures were virtually impossible to measure with available spectrometers under field conditions. The light reflected from the fish was so rapidly attenuated by the water that the spectrometer was unable to record significant spectral differences between the fish schools and their water environment.

Remote Underwater Fisheries Assessment System

The Remote Underwater Fisheries Assessment System (RUFAS) consists of a towed submerged platform equipped with lights, television and photographic cameras, and acoustic transducers (Seidel, 1970). It is flown several feet above the ocean floor by scientists aboard a research vessel using acoustical signals and television images to regulate flight. The system has been upgraded and used extensively by the NMFS Brunswick and Miami laboratories off the southeast coast of the United States for photographic surveys of calico scallop, *Argopecten gibbus*, beds (Fig. 10).

The first RUFAS system was so well received by marine investigators that an improved system, RUFAS II, was developed as a joint venture between Sea Grant and NMFS/SEFC. The principal differences are in design depth (400 fathoms compared with the 50-fathom depth limitation of RUFAS I), and an automatic flight control capability. RUFAS II can be programmed to fly at a constant height above the ocean floor, whereas RUFAS I has to be manually flown.

Hydroacoustics

The NMFS must develop an operational acoustic system for detection and quantification of fishery resources to meet the operational requirements unique to southeastern U.S. fishing conditions. Under contract to NMFS, the MIT Charles Stark Draper Laboratory developed a mathematical model which was assumed to provide unbiased estimates of the number of reflecting targets (fish) in an acoustical echo signal. An experimental program was initiated to test the model (Gandy, 1973) in a large water-filled tank with arrays of plastic-ball targets (Fig. 11). The experiments, however, did not validate the acoustic model. Subsequently, another mathematical model was developed that provided accurate estimates of target density based on the experimental data (Stevenson, 1974). Further testing will be required, however, before this model can be employed in an operational acoustic system.

In another application of acoustic

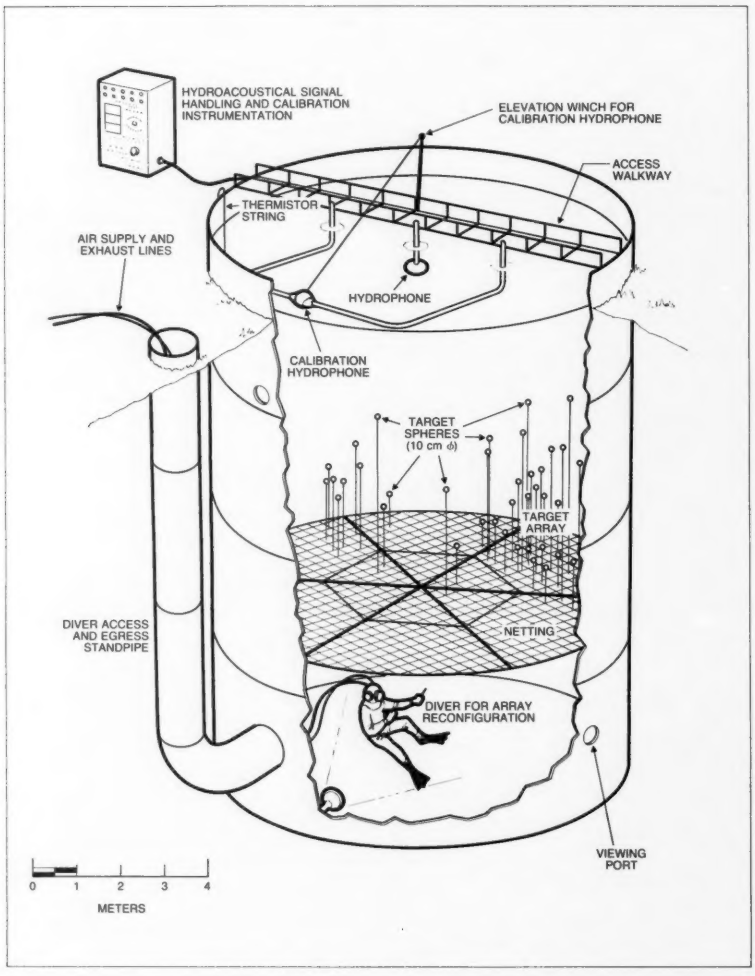


Figure 11.—Test configuration for testing hydroacoustics mathematical model. (Stevenson, E. A., and W. S. Shepard. Theory for hydroacoustic multiple target scattering assessment with experimental verification. Acoust. Soc. Am., San Franc., Calif., Nov. 1974. Unpubl. rep.)

technology, an imaging device (Shadowgraph), loaned by the Naval Coastal Systems Laboratory, was tested to determine its application to fishery resource assessment problems, and for locating and identifying underwater fishing obstructions. The experimental approach was to deploy the underwater acoustic imaging device and RUFAS over identical targets. Using the optical imagery from RUFAS as a standard, the acoustical image could then be analyzed for resolution and sensitivity.

The acoustic imaging device appeared to obtain adequate bottom profile and underwater obstruction data. The effectiveness of the system as a resource assessment tool was not definitively established. Further testing is planned.

SAMPLING AND ANALYSIS SYSTEMS

Sampling activities, especially in an assessment or exploration mode, require an understanding of the efficiency of the sampling device and the environmental conditions of the area being sampled to develop reliable evaluations of the resulting catch. Furthermore, the tedious process of manually analyzing the biological samples cannot keep pace with the demand for the resulting data. Studies have been undertaken to apply modeling techniques and advanced technology to ultimately provide better analytical results.

Net Systems Studies

A bongo net was selected to serve as a basis for the development of a theoretical approach to the understanding of plankton sampling systems. The object of the study was to mathematically describe the performance of different net systems. The approach considered system dynamics, hydrodynamic forces, sound and pressure fields, and consisted of mathematical and empirical studies. Preliminary studies resulted in a series of design improvements which were forwarded to the NMFS Marine Resources Monitoring, Assessment, and Prediction (MARMAP) Office.

Preliminary engineering studies also were completed on the development of a high-speed nektonic neuston sampler designed for minimum specimen damage. Numerous net configurations were considered, and a small boat hull capable of being towed to one side of a ship's wake at speeds up to 15 knots was proposed (Fig. 12). The proposed system consists of an opening on the forward undersurface which would divert water into a chamber shaped to accommodate a spray trajectory. The top of the boat's midsection was designed in the form of a dome, also conforming to a spray trajectory, to lead the spray into the mouth of a net. The net would retain the plankton while exit tubes in the stern emptied the boat in the manner of a self-bailing cockpit.

Both projects demonstrated a potential application to problems related to fisheries research. In each case, however, fiscal constraints caused further efforts to be held in abeyance. If completed, the plankton sampling system study would have produced: improved data leading to an understanding of the physical and biological processes of plankton sampling; minimization of data uncertainties and correlation of data from different systems; and optimization of conventional designs and determination of their limitations. Development of the high-speed neuston sampling system would have resulted in an increased availability of samples to facilitate more emphasis on studies related to the neuston component.

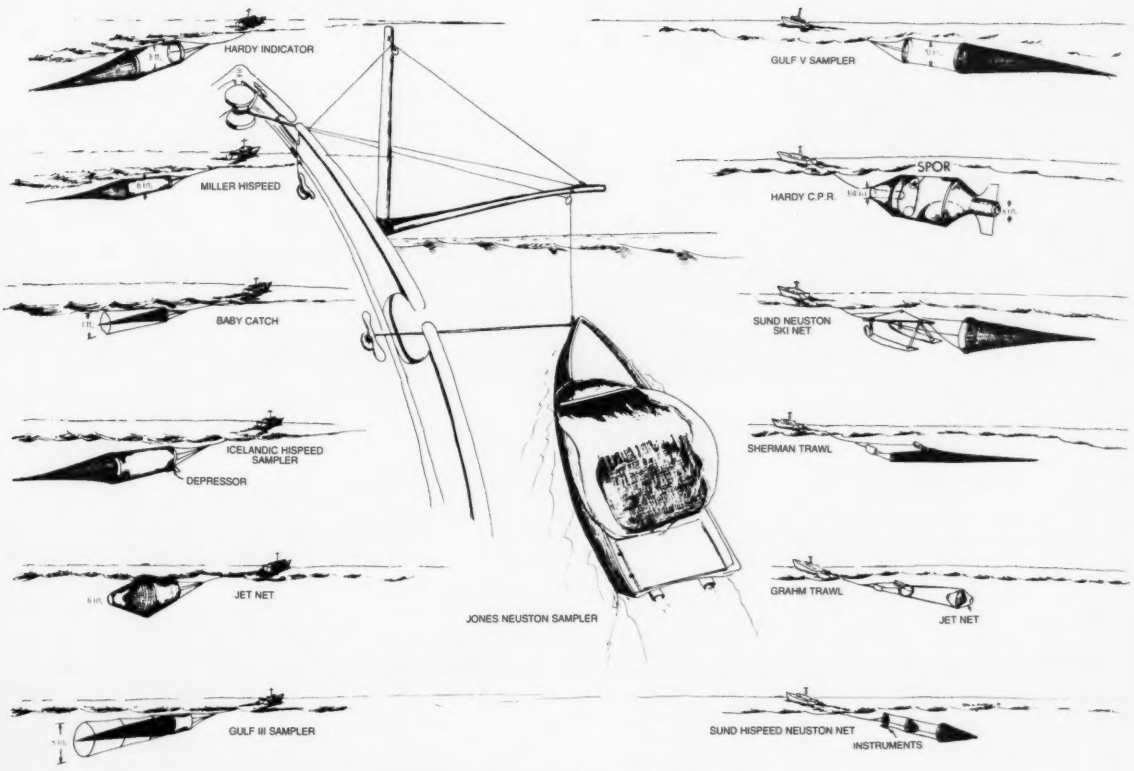


Figure 12.—Neuston sampling system net configurations.

Electric Shrimp Trawl Resource Assessment Survey System

The electric shrimp trawl is the first trawling system with an accurately defined catch rate. This catch rate was determined through statistical modeling based on carefully controlled laboratory experiments and field tests. Animal behavior information in response to an electrical field, together with the effects of physical parameters such as water temperature, salinity, bottom type, electrical field strength, and towing speed, were variables in the model.

It has been shown that throughout a nighttime fishing period, most shrimp are burrowed (Wickham and Minkler, 1975). Therefore, accurate resource assessment information cannot be obtained by standard trawls because the number of burrowed shrimp at any particular time is unknown.

With a defined catch efficiency, catch results are directly relatable to resource abundance during daytime shrimping. During nighttime hours, the catch increase produced by the electric shrimp trawl, compared to a standard trawl, represents the number of shrimp still burrowed. By comparing the catch of a standard trawl and increased catch of an electric trawl, the catch rate for the electric shrimp trawl at night is defined in terms of actual resource abundance encountered by the trawl.

Automatic Fish Scale Reading System

The feasibility of developing an automated system for aging fish scales was investigated. Currently, most scales are manually read by determining the relative distances between microscopic ridges (circuli) on the scales. The spacing between the circuli corresponds to the growth rate of the fish. When growth is minimal, the circuli tend to grow close together forming annuli; the number of annuli on a scale represents the age of the fish.

Two study contracts were awarded for alternative aging devices. The first was for the evaluation of an automatic image analysis system. This system, which converted circuli and annuli to gray-scale densities for comparative analysis, did not approach the 75-percent repetitive factor achieved by manual processes. The second contract was for the application of a recording optical spectrum analyzer—a diffraction pattern sampling technique. This system appeared to have potential and the recommended future action was to pursue this approach.

Automatic Plankton Sorting System

Thousands of plankton samples are collected annually by NMFS investigations, and manually sorted, counted, and identified. The purpose was to develop a method to expedite the process. At the same time the Northeast Fisheries Center (NEFC) was

working toward a similar goal. After consultation, it was agreed that NEFC would continue to work toward developing a sorting system and SEFC/FEL would concentrate on the development of an automatic transport method which would move sorted plankton through a counting system.

An evaluation of current and potential systems was conducted. A hydraulic transport system was developed based on a system used by the Fisheries Research Board, Nanaimo, British Columbia. Numerous tests were conducted and two minor problems were corrected. The system was shipped to the MARMAP Field Office in November 1973.

Trawl Door Instrumentation

The development of an environmental sensor for use in conjunction with trawl surveys for bottomfish is being investigated through a cooperative program with the Naval Underwater Systems Center, Newport, R.I. The concept is to design a self-contained miniaturized sensor package for attachment to trawl doors. The system will measure and record salinity, temperature, and depth over a 3-day survey period without servicing. Data from the sensors will be used to develop bioenvironmental correlations which can aid significantly in establishing future survey designs and in enhancing understanding of marine ecology.

HARVESTING TECHNOLOGY AND CONSERVATION ENGINEERING

This program has two primary goals: 1) increased levels of harvest by U.S. fishermen; and 2) conservation of nontarget resources which are damaged subsequent to other harvesting activities. Of major interest is the development of systems to harvest unutilized resources in the southeast region. Presently, many of these resources are unavailable to the U.S. commercial fishing industry because they are not economically harvestable with conventional fishing methods or gear. During system development, emphasis is placed on conserving nontarget species and inflicting minimum damage to the associated habitat.

Electrical Fishing

Studies of the effect of electricity on fish have been conducted for many years. Past studies have used either direct current or long-duration pulses to control fish. Therefore, the area of the marine environment from which fish could be effectively harvested was always limited, and the technique had little or no commercial application.

Laboratory experiments were conducted (Klima, 1972) to identify the electrical characteristics required to induce electrotaxis as a means of controlling and leading fishes. A modified electric generator was used to produce pulsed direct current in the form of capacitor discharges at rates of 5-75 per second. An index of optimal responses was obtained for selected species (Table 1).

Based upon the results of the fish behavior study, an electrical pulse generator system was designed for both commercial and resource assessment applications. A 120 kilowatt pulse generator was constructed and installed aboard the FRV *Oregon II* for in situ field tests (Seidel and Klima, 1974). Fish were attracted to the electrode array and their responses to various combinations of electrical fields and pulse rates were evaluated. Based on these tests, the system was modified and an updated version is now installed on the FRV *Oregon II* to provide a capability to lead and control pelagic fishes to facilitate rapid, efficient capture and harvest.

Table 1.—Effective combinations of voltage (per 10 cm) and pulse rate (per second) for inducing electrotaxis in the species studied and the approximate amperes (per square meter) (Klima, 1972).

Species	Volts	Pulses	Amperes	Fish length (mm) Range	Average
Coastal pelagics					
Scaled sardine	1.5	15-55	62.5	100-145	118
	3.0	8-28	86.5	100-145	118
Spanish sardine	1.5	35-45	43.3	85-180	130
	3.0	15	86.5	85-180	130
Round herring	3.0	25-45	86.5	80-150	104
Silver anchovy	3.0	35-45	98.3	85-110	96
Butterfish	1.5	35	41.3	80-100	118
	3.0	45	86.5	80-160	118
Chub mackerel	1.5	15	53.8	125-240	180
Bumper	1.5	15	57.0	135-230	173
Rough scad	1.5	15-25	42.3	120-145	133
Thread herring	1.5	15	62.5	80-185	146
Round scad	1.5	15	43.3	90-170	148
Bottom fish					
Spot	1.5	15-35	43.3	90-250	120
Longspine porgy	1.5	25-35	43.3	100-160	128

Electric Shrimp Trawl System

The electric shrimp trawl system can potentially increase shrimp production in excess of 100 percent. Initially developed to expand shrimping to daylight hours, it was determined that the system would also significantly increase the nighttime harvest of shrimp. Studies have shown that the majority of shrimp are burrowed even at night and therefore are unavailable to conventional trawls (Wickham and Minkler, 1975).

Electrical response characteristics were established to properly stimulate shrimp from the bottom in such a manner that they could be harvested by a trawl during daylight and nighttime hours. A pulse generator and associated hardware were designed, utilizing the shrimp response requirements, and a complete electrical system was built for a shrimp trawl. The system was tested to demonstrate the feasibility of a commercial electric shrimp trawl system and, based on the results, a commercial unit is presently under development for the shrimp industry by two different companies.

The electric shrimp trawl also can be used to provide accessibility to new shrimp grounds. Areas now unavailable to standard shrimp gear, because of bottom roughness, can be opened for sampling or harvesting through modifications of this system.

Shrimp Separator Trawl

Estimates place the amount of groundfish destroyed during commercial shrimping operations at between 1 and 4 billion pounds of fish annually. This represents a significant loss to both the pet food and human food groundfish fisheries. A shrimp separator trawl is being developed with a design goal of reducing the capture and subsequent destruction of groundfish by 90 percent. Preliminary studies indicate that these goals are

feasible and, if attained, a significant conservation of the groundfish resource will have been achieved.

Research of other separator trawl designs determined they were unsuited for use in the Gulf of Mexico, although fish portions were reduced by 50-60 percent. Therefore a new net design was formulated based on direct diver observation of shrimp and fish behavior during trawling operations. A prototype separator trawl was designed and constructed, using results obtained from laboratory studies and three preliminary cruises (Fig. 13). Test results of the prototype were encouraging: sponges and crabs were eliminated; fish portions were reduced; and shrimp loss was miantained at 10-15 percent of normal. This system will be further developed and tested to optimize its selectivity for commercial use.

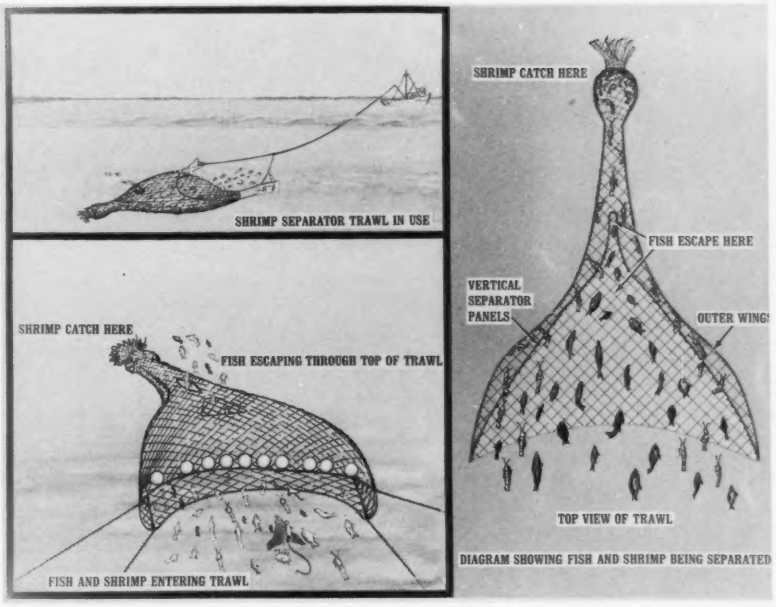


Figure 13.—Separator trawl concept.

Nightlighting for Attraction and Control

Extensive behavioral studies formed the basis for the development of techniques to concentrate fish at night with lights. Subjective observations indicated that fish could be attracted by a wide range of lamps and light intensities (Wickham, 1971). Conclusions were that a single high-wattage point-source lamp created the most controllable aggregations, and underwater lamps were more efficient than surface lamps.

Lighting attraction and control methods were first evaluated for commercial application using coastal pelagic fish harvested in the Florida baitfish fishery. A single light used in conjunction with a conventional purse seine yielded approximately 1,814 kg (4,000 pounds) of fish in 3 hours. Multiple lights, properly spaced, acted as independent attraction points and it was demonstrated that fish attracted to one light could be led by sequentially illuminating the series of lights. A single moving light also proved successful in leading fish (Wickham, 1973).

Artificial Structures As Attractors

The Gulf of Mexico coastal pelagic resource is generally not found in large concentrated schools. Normally, numerous small schools are found scattered throughout an area. Artificial structures were found to be effective in attracting and holding these fish in increased numbers for harvest.

Attraction structures were evaluated through a contract to a Florida commercial fishing company. Purse seine sets were made around the artificial structures to determine the rate and effectiveness of the structures for concentrating commercial numbers and species of fish. The information obtained from this study showed that coastal pelagic fish could be concentrated in numbers greater than those in which they are normally found (Klima and Wickham, 1971).

The structures were also evaluated as a technique to improve or enhance the catch of sportfishermen (Wickham et al., 1973). Through a joint study with the NMFS Game and Sportfish Laboratory in Panama City, Fla., it was demonstrated that the artificial structures could significantly improve the strike and catch rate of sportfish in an area. As a result, several structures have been made by State and Federal agencies to further evaluate the potential of this technique.

DATA MANAGEMENT

Expanded survey programs, covering vast oceanic areas and intensively studying discrete areas, will produce massive quantities of environmental and biological data. The full value of these data cannot be realized, however, without comprehensive processing and display systems nor can their full significance be economically attained without automated analysis systems. Traditionally, data processing has been generally directed toward presenting information about discrete areas without correlation with other areas and without looking at vast areal coverage. The objective of this program is to develop systems capable of integrating vast amounts of information while maintaining a capability for discrete analyses.

Data Logger System

This study was initiated to develop a portable data acquisition system capable of automated shipboard data recording of ship performance and configuration, and oceanographic, meteorological, and biological parameters (Fig. 14). The design concept was to develop an analog system, with a quick-look capability, in modular units. Off-line computer programs were developed to provide summary data for each station in general plot and tabulation formats.

Each hardware unit was designed to be packaged in nearly self-sufficient operating enclosures called "cubicles". Individual components within each cubicle were also modular allowing a partial mix of two or

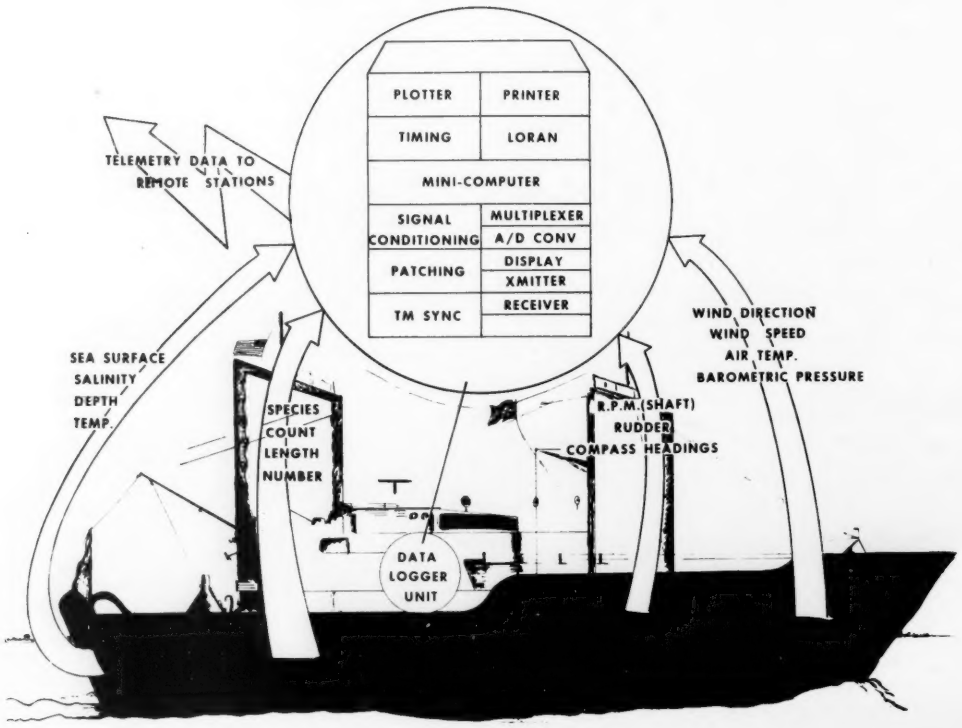


Figure 14.—Parameters measured by the data logger system.

more systems in a single cubicle. A prototype system was fabricated and installed aboard the FRV *Albatross IV*.

Information Management System

A Center-wide system is being developed which consists of software that facilitates organization, storage, retrieval, and updating of large amounts of data. The system will use a simple user language to allow flexible data file structuring and maintenance, and virtually unlimited information retrieval selectivity. Random access data storage and retrieval techniques will allow access to data without sequential searches and will eliminate storage of filler or other irrelevant characters.

The Information Management System will use data management techniques developed to satisfy LANDSAT and other satellite-related requirements (Fig. 15). The system can be generally divided into three main segments. The first (unit conversion and reformatting) is being developed to reformat all incoming digital data for input to the Information Storage and Retrieval System (ISRS). The ISRS will enable users to selectively retrieve pertinent information subsets from the compressed file, print the information, or store it on magnetic tape for use in analytical routines.

The last segment will consist of software elements for data display and analysis. These elements will include statistical and mathematical routines, and graphical displays (by incorporating the Atlas Display System) such as land-mass plots with contours and symbols, histogram plots, and X-Y plots. The goal is to use a central computer facility with connecting terminals at other NMFS laboratories.

Atlas Display System

An atlas display system was developed to display biological and environmental data as a function of time and location. The goal was to establish a data management tool to study the interactions of these variables, and to provide a real-time assessment and management display device for studying and managing marine resources.

The first step was to develop plotting routines consistent with available plotter requirements. Software was developed to plot, contour, and display the variables, to accept inputs of discrete functions and to display composite frames of data. In addition, a system to display integrated data in an annotated form was developed.

The first major application of this system concentrated on the dispersal mechanisms of the transport and distribution of phyllosomes (lobster larvae). Using surface current velocities and drift-bottle data, film sequences were constructed showing phyllosome drift paths based on assumptions of starting points and time of the year.

Exploratory Fishing Data Base

A groundfish resource assessment data management and display system was developed. This software package provides a

master file and update capability for all groundfish exploratory survey data, which currently consists of approximately 400,000 observations. The master file can be displayed spacially to provide a symbolic representation of species distributions, catch rates, and sampling stations. Also, the display software has the capability of displaying the 5-, 20-, and 50-fathom depth contours on the same catch-rate plot. A current master data file is maintained at the FEL for this project.

Utilizing a subset of the above data, a North Carolina coastal summary atlas was prepared. Software was developed to normalize and plot the North Carolina data by species showing distribution and catch rates spacially in conjunction with the coastal land mass. Approximately 130 different plots were prepared utilizing a Stromberg Carlson SC4020 microfilm plotter[3]. The plots represented approximately 11,300 observations of the distribution and availability of selected species taken by various gear.

In support of a Food and Agriculture Organization project, exploratory fishing data were processed and displayed for the southeast region. The project included computations of groundfish and crustacean biomass estimates, and distribution and catch-rate plots (including land-mass outlines). Computation of catch rates for estimating the efficiency of trawl configurations, ultimately for biomass calculations, were also provided. Subsequently, distribution plots using other exploratory fishing data were provided for the Campeche/Yucatan area.

Preparation of a shrimp atlas has been initiated for the Atlantic Coast from North Carolina to Florida. Software was developed to interrogate the file for the purpose of counting sampling stations (records) by region, shrimp species (white, pink, and brown), and month. Further counts were made to determine the number of stations in each subset having measurements of depth, temperature, and weight, and number of shrimp. The same procedure was followed for each state, by season and species. A second computer program was developed to sort species data by region, season, time of day, and sampling device. Catch rates were normalized to a 12.2-m (40-foot) shrimp trawl and a 1-hour sampling period.

[3]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

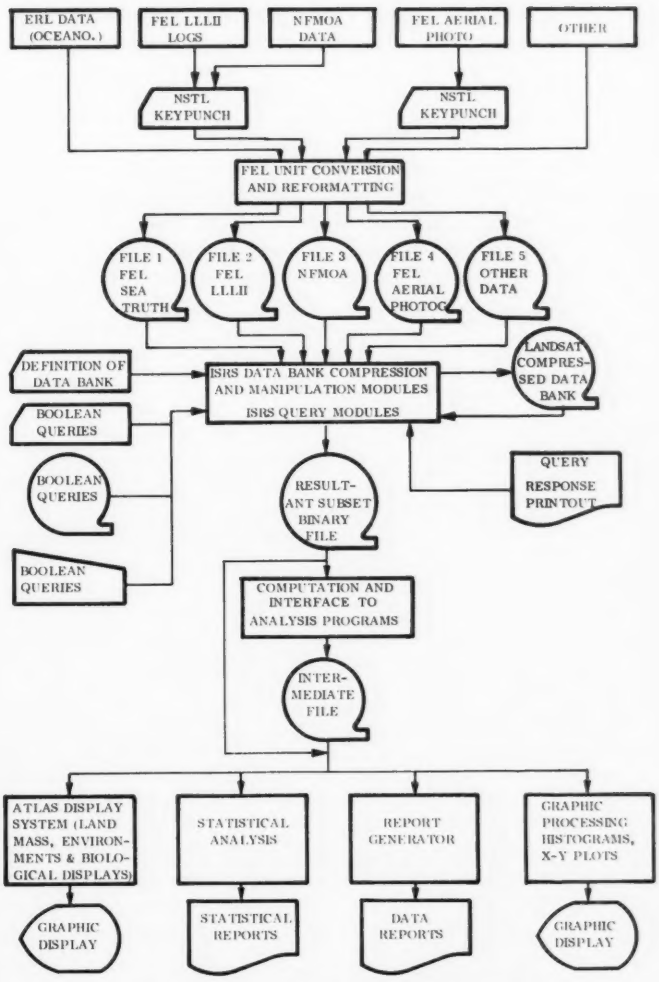


Figure 15.—LANDSAT data management software system.

Law Enforcement Data System

A data storage and retrieval system has been developed for the NMFS Southeast Regional Law Enforcement Office in New Orleans. The system has the capability to add, change, and delete data associated with a master surveillance file. It also has the capability for outputting up to 14 different tabulations of the data with each tabulation emphasizing a different aspect of the data. Current plans call for adding several refinements to the system including the capability to display the location and time sequence of fishing violations utilizing the atlas display system.

PLANNING AND SYSTEMS ANALYSIS

Planning and systems analysis are decision-making processes which result in bringing into focus the objectives of a project and the methods of attainment. Emphasis can be placed on one of two primary aspects: the fact-finding process of planning or the decision-making process. The two aspects are inseparable since sound management decisions can be accomplished only after an evaluation of all the related factors has been concluded. These principles have been applied to activities being

conducted at FEL, and in several instances to other NMFS functions.

Regional Recreational Fishing Program

A Marine Recreational Fishing Program Development Plan was prepared at the Southeast Fisheries Regional Office in 1975. FEL provided systems engineering and planning support to insure total integration of all the elements inherent to marine recreational fisheries management in the southeast. The plan is intended to solidify and provide impetus to research and monitoring and assessment activities related to marine recreational fishes in the southeast.

Cruise Track Optimization

An automated system is being developed for cruise track and station selection as a function of survey objectives. This system is expected to significantly reduce the amount of effort currently being expended in selecting survey stations and the order in which they are sampled. The system will be flexible enough to compensate for delays and other unforeseen contingencies during survey operations.

During a literature search at the onset of the project, a software system already developed for optimizing salesmen's routes was identified as having direct applicability. In its fisheries survey application, an augmented random number generator was added to select survey stations within predefined survey areas and then to optimize the cruise track between stations. The system has been compiled on the Univac 1108 and tests are being conducted to demonstrate its operational capability.

Extended Jurisdiction Fisheries Management

The United States has assumed jurisdiction over fisheries resources out to 200 nautical miles. Inherent in this extension is responsibility for the protection and utilization of these resources. Significant effort will be required to develop the body of knowledge and systems necessary to support this action.

The NMFS established an office to plan the activities required to support extended jurisdiction. FEL supports this office by providing systems engineering and planning support. Initially, a series of management displays were developed to enhance the planning ability to respond to required actions and anticipated problems.

Fishing vessel surveillance will play an important role in extended jurisdiction. FEL has initiated the conceptual design of remote sensing systems to locate, identify, and monitor fishing vessels (domestic and foreign) within or near the 200-mile limit. To meet initial requirements, the concept of a system involving cooperative and noncooperative components was proposed. The cooperative component normally would require conscientious participation of a fishing vessel captain, such as periodic radio transmissions to a land station providing information on location, activity, and catch.

The noncooperative component essentially would serve to validate the information received through the cooperative component. One noncooperative component being considered is an imaging radar unit, such as the type included in the Sea Satellite (SEASAT) suite of instruments. Preliminary tests of this unit have been conducted over foreign fishing vessel concentrations off Georges Bank and the Gulf of Alaska. Data analysis is in progress.

THE FUTURE

Technology is advancing at an unprecedented rate and the potential applications to fisheries problems are limitless. Techniques such as lasers, high-resolution color television, and hydroacoustics will be investigated more thoroughly. The advent of the SEASAT will provide the first opportunity to use data acquired by satellite systems designed specifically for oceanographic purposes. Data management techniques will be expanded and improved to provide more comprehensive, workable data bases to process and analyze massive quantities of integrated data. Harvesting systems will be developed and improved to facilitate harvests of latent resources and selectively harvest target species. However, the key to the future lies in the successful transfer of new techniques to user groups and the recognition by users that the new techniques can successfully replace the old standards.

ACKNOWLEDGMENT

This document is based upon the efforts and output of the entire Technology Division staff—past and present. Through their combined expertise, significant accomplishments can be reported and continued success predicted.

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U.S. Commercial Fish Landings Jump in 1976

United States commercial fishery landings for 1976 are forecast to be 5.2 billion pounds—the largest in 10 years, according to the National Oceanic and Atmospheric Administration's National Marine Fisheries Service. This represents a 7 percent increase over 1975. "Fishery landings" is the amount of fish brought to docks by fishermen.

The record dockside value—exceeding $1 billion—is due to a steady increase in foodfish catches and to generally rising prices. The Commerce Department agency says that total quantities of domestic tuna processed by California canneries are running at least 10 percent ahead of 1975, as are those of domestic fish at canneries in Puerto Rico (Puerto Rico data are not included in the 5.2 billion-pound total catch).

Total production of shrimp in the Gulf of Mexico is up by a third, according to NOAA figures, and Alaska shrimp is expected to be up 20 percent or more. Alaska snow crab should set a new record. Pacific salmon are up about 40 percent over 1975, after two successive poor years. Landings of Maine sea herring, American lobster, and sea scallops are expected to be up, as are those for cod and flounders.

Landings of fish used for processing into meal and oil also appear to be above the 1975 levels. Increased production of Atlantic and Gulf of Mexico menhaden will offset a decline in California anchovy. Heavier-than-expected production of menhaden and anchovies in December could make 1976 the best year for such industrial fish since the record year of 1962.

The chief declines will be in clams and blue crabs. Resource problems with the surf clam now restrict Atlantic clam landings, which are expected to be down by a third from last year. Total Atlantic and Gulf of Mexico blue crab production will be off by about 25 percent, but fairly large resource fluctuations are normal in this fishery.

The first comprehensive report on U.S. commercial fishery landings for 1976 will be contained in "Fisheries of the United States, 1976" scheduled for publication in April 1977. Copies may be ordered by writing to: Director, National Marine Fisheries Service, NOAA, Washington, DC 20235.

NOAA Funds Maryland Oyster Industry Study

The University of Maryland has received a Sea Grant of $441,200 from the National Oceanic and Atmospheric Administration (NOAA) to be used in part to study the threatened Maryland oyster industry and to assess the water quality of the 2,000-square-mile Chesapeake Bay area. The grant will be augmented by almost $300,000 in matching funds from the University.

Although the University of Maryland has received support from the Office of Sea Grant in the past for its Marine Advisory Service program and for individual marine research projects, this marks the first time the College Park institution has received funds for a coherent program of marine research and advisory services. The Sea Grant Office is an element of the Commerce Department.

Under the current grant, a number of projects devoted to Maryland's oyster resource will be undertaken. During the late 1960's, the state accounted for more than one quarter of the nation's oyster production, nurturing a fishery that had a dockside value of almost $10 million annually. Recently, however, the Chesapeake Bay oyster population has not been reproducing at its previous rates and, as a result, has not been able to keep pace with harvesting and natural mortality.

Scientists will collect and analyze historical information on harvesting, fishing effort, and natural repopulation in an attempt to predict harvests in future years. Other Sea Grant-supported researchers will try to determine why some areas of the Chesapeake are highly oyster productive and others poor. The scientists also will evaluate a method called "sprinkle planting"—the depositing of male oysters on natural oyster beds comprised primarily of larger, female oysters to stimulate spawning. According to the Maryland Sea Grant scientists, the method could aid in rehabilitating oyster bars in the Chesapeake that are now dominated by female oysters.

Work on bacterial contamination of shellfish in the Bay, begun last year, will continue under the current grant. A team of microbiologists will attempt to determine both the natural and human-related microbial levels in shellfish harvesting areas. The information, now being stored in a special computer data bank, is expected to be of help to the Maryland Department of Natural Resources in its management planning.

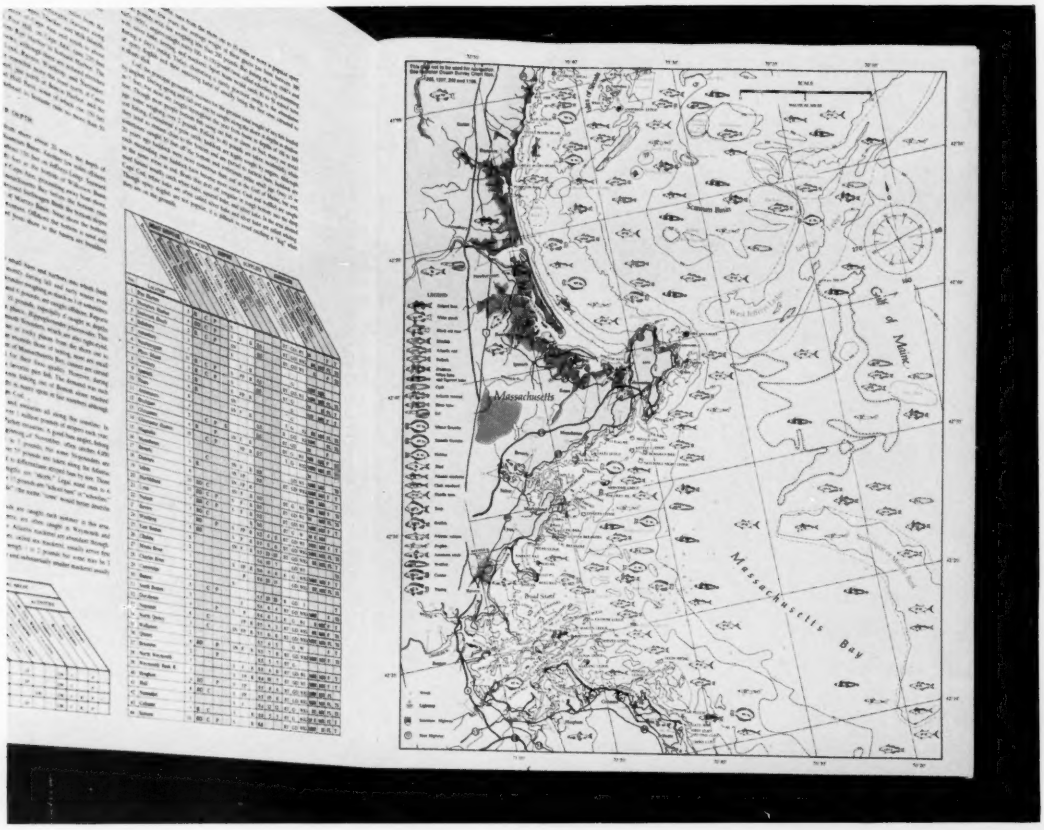
In related work, researchers will monitor the levels of certain hydrocarbons in water, sediments, and shellfish from oil-polluted and unpolluted areas of the Bay to assist the state in its resource management. The study will be especially valuable with respect to dredge spoil disposal and the siting of oyster beds, according to the researchers.

U.S. Atlantic Coast Angler's Guide Printed

The four final sections of one of the most extensive and detailed marine sport fishing guides, "The Anglers' Guide to the United States Atlantic Coast," has been published by the Commerce Department's National Oceanic and Atmospheric Administration (NOAA). Subtitled "Fish, Fishing Grounds, and Fishing Facilities," the 14-× 16½-inch guide thoroughly covers marine angling from Maine to Florida in eight separate sections.

The Anglers' Guide was authored by Bruce L. Freeman and Lionel A. Walford of NOAA's National Marine Fisheries Service laboratory at Sandy Hook, N.J. Freeman and Walford consulted extensively with commercial and sport fishermen, coastal wardens, outdoor writers, State and Federal fisheries biologists, and operators of marinas, bait and tackle shops, and boat liveries. Other important information was supplied by state park, forest, and recreation agencies as well as the National Park Service, and the U.S. Fish and Wildlife Service.

The most common and popular sport fish in each coastal section are described, including common and scientific names, and sizes:



average; "unusually large"; largest; and the tackle record. Each species' preference for bottom type and depth, temperature, and information on the season caught and best fishing conditions are listed. Tips on the best fishing methods and the most popular and productive baits and lures are also given.

General arrival times of migrant sport fish are told as are other seasonal movements and the habits of year-round resident species. Ocean floor configuration is described along with general tide and weather conditions. Other items of interest include the effects that pollution, estuarine development, and overfishing have had on fish stocks and the marine sport fishery. Marine fishing is traced from earliest European exploration and colonization for most coastal sections and the decline of some of the fish stocks is noted.

Detailed descriptions of the fish, fishing areas, and techniques are complemented by colorful, chart-sized maps which indicate the best fishing grounds and other information. Map features of interest to anglers include shoals, gullys, ledges, banks, wrecks, lightships, jettys, bars, reefs, channels, canyons, whistle buoys, and the like. On land, national and state parks, forests, wildlife areas, campsites, principal roads and towns, wetlands, etc. are shown. Though the maps are not intended for navigational use, numbers of corresponding National Ocean Survey charts are listed for reference.

Tables keyed to each map provide extensive data on sport fishing facilities, supplies, and services. The number of boating facilities per location is given and available rentals are classed as rowboats, outboards, charter boats, party boats, runabouts, or skiffs. Launching ramps (surfaced or natural), and hoists (fixed or portable) are listed if available, as are marine railways. Tidal ranges, and approach and alongside depths are given in feet. Supplies and services mentioned include bait, tackle, gasoline or diesel fuel, water, ice, groceries, moorings, berths, electricity, motor or hull repairs, food, lodging, toilets, and showers. A 72-word glossary in each section defines words ranging from "Anadromous" to "Wet Fly."

The recently-published sections (V-VIII) are the second half of the eight-section Atlantic coast study. Section V ($1.60) covers the Chesapeake Bay; Section VI ($1.70), False Cape, Va., to Altamaha Sound, Ga.; Section VII ($1.70), Altamaha Sound, Ga., to Fort Pierce Inlet, Fla.; Section VIII ($1.80), St. Lucie Inlet Fla., to the Dry Tortugas.

The first four sections, published in 1974, covered the area from Maine to Virginia: Section I, Passamaquoddy, Maine, to Cape Cod ($1.60); Section II, Nantucket Shoals to Long Island Sound ($1.60); Section III, Block Island to Cape May, N.J. ($1.70); Section IV, Delaware Bay to False Cape, VA. ($1.60). All sections can be ordered from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Operation Fish Watch Keeps Tabs on Fish Prices

The retail price index for fish rose 0.9 percent in November 1976 from October 1976, states "Operation Fish Watch," a monthly statistical analysis by the National Marine Fisheries Service (NMFS).

Of the 17 fishery items surveyed, nine advanced, six declined, and two were unchanged. Prices decreased slightly for canned red salmon, cod fillets, and fish portions. On the other hand, prices increased for halibut steak and canned shrimp.

Surveyed in the frozen category: ocean cod, flounder, haddock, whiting, and turbot fillets; halibut steak, raw headless, peeled and deveined, and (canned) shrimp; and king crab meat. In the canned category: solid white and chunk light tuna; pink and red salmon; and Maine and Norway sardines.

In comparison to the increase in fish prices, the November retail price index for meat rose 1.2, and for poultry dropped 6.4 percent a pound to 50 cents — turkeys declined 5.6 percent.

Ten cities are surveyed every month by officials of NMFS, a part of the National Oceanic and Atmospheric Administration under the Department of Commerce. These officials report prices of selected items of fish, meat, and poultry for "Operation Fish Watch," a service that was started in April 1973. The officials visit three different chain stores in each city and check the prices for the same representative brand names and types of products to ascertain any changes from the previous month.

The cities surveyed are Atlanta, Ga.; Boston, Mass.; Chicago, Ill.; Galveston, Tex.; San Francisco and Los Angeles, Calif.; Pascagoula, Miss.; St. Petersburg, Fla.; Seattle, Wash.; and Washington, D.C.

Sapelo Island Is Second U. S. Estuarine Sanctuary

Wetlands of a barrier island on Georgia's coast have become the Nation's second estuarine sanctuary, Robert M. White, Administrator of the National Oceanic and Atmospheric Administration, and Georgia Governor George Busbee announced late last year.

As such, a portion of Sapelo Island and the immediate vicinity will be preserved in their natural state, free from modern development, and serve as a model for measuring human impacts on similar estuarine areas.

The sanctuary was established at a ceremony in the State Capitol, Atlanta, early in December. Participating were Governor Busbee, Lt. Governor Zell Miller and Department of Natural Resources Commissioner Joe Tanner from the State of Georgia, Alfred Jones of the Sapelo Island Research Foundation (SIRF), Robert Knecht of the National Oceanic and Atmospheric Administration (NOAA), and other State and Federal officials.

"The Sapelo Island National Estuarine Sanctuary is a Christmas present to the people of the Nation from the State of Georgia, the Sapelo Island Research Foundation, and NOAA" said Knecht, NOAA's Associate Administrator for Coastal Zone Management. "Its 7400 acres will remain a permanently protected, unspoiled area—a natural laboratory for scientific research and education."

To establish the sanctuary, the State of Georgia and SIRF contributed a total of $4.2 million in funding and land value, and NOAA granted $1.5 million.

The sanctuary includes the southern portion of Sapelo Island, the entire Duplin River, adjacent wetlands, and surrounding areas. It borders the R.J. Reynolds Wildlife Management Area (named after the last private owner of Sapelo Island), the Sapelo Island Natural Area, and the tiny community of Hog Hammock (pop. 300), a traditional settlement rich with black cultural heritage. Located within the sanctuary is the University of Georgia Marine Institute, which has conducted extensive research on Sapelo for more than 20 years.

The Duplin River estuary is ecologically typical of estuaries along the South Atlantic coast. Such estuaries, located from Cape Hatteras, N.C., to Cape Kennedy, Fla., are typified by extensive marshes and swamps, turbid and productive waters, and a range of plant and animal life generally found in temperate climates, with seasonal tropical elements.

Research in the sanctuary will include: 1) Acquisition of baseline data, including a full description of the natural biophysical characteristics of the estuarine ecosystem; 2) systems analysis and related studies to permit construction of models showing the function and interaction of components of the ecosystem; 3) long-term monitoring to measure the character and extent of natural and of man-induced changes in the area; 4) assessment of the impact of management policies and uses of the natural resources of the estuarine systems, including socio-economic impacts, and basic studies in such areas as physiology, microbiology, and biochemistry.

While not intended as a recreational area, the sanctuary will be available for "low intensity" recreation use by the general public, so long as the level and kind of use do not detract from or alter the natural environment. Such activities as fishing, crabbing, and hunting will be permitted.

Camping will also be allowed, but no special facilities such as improved roads or campsites may be constructed or provided within the sanctuary. The use or discharge of pollutants, including pesticides, herbicides, and fertilizers within the sanctuary will be prohibited.

Ownership of the sanctuary is with the Georgia Department of Natural Resources. The State Office of Planning and Budget will coordinate the estuarine sanctuary program within the state's coastal management program. Federal funds for the sanctuary were provided by NOAA under the Coastal Zone Management Act of 1972. The nation's first estuarine sanctuary was established in 1976, in Coos Bay, Oreg.

U.S. Fishermen Allowed Limited Access in Mexico's 200-Mile Zone

An agreement between United States and Mexico provides limited U.S. fishing activities within Mexico's 200-mile economic zone, according to the National Oceanic and Atmospheric Administration's National Marine Fisheries Service. The agreement was signed last year by Ambassador John Jova for the United States and by Foreign Minister Alfonso Garcia Robles for Mexico, and now is in effect.

The agreement authorizes limited access for U.S. fishermen to traditional fisheries within 12 miles of the west coast of Mexico. The U.S. vessels are also authorized to harvest surplus portions of the total allowable catch, determined by Mexico, of snapper and grouper, shrimp, and associated incidental fishes within the 12-to 200-mile zone off Mexico's Gulf coast. Moreover, continuation of the U.S. fishery for highly migratory species in that zone is permitted.

The United States has accepted the concept of phase down-phase out regarding its shrimp fishery within the Mexican 12- to 200-mile zone. The schedule is as follows:

Period	Metric tons	No. of vessels	Percent reduction
1 Aug. 1976-31 July 1977	2,750	318	40 percent from previous levels
1 Aug 1977-31 July 1978	1,925	223	30 percent from 1st year of agreement
1 Aug 1978-31 July 1979	1,100	127	60 percent from 1st year of agreement
1 Aug 1979-31 Dec. 1979 (5 months)	344	95	70 percent from 1st year of agreement

The U.S. vessels will fish only on the Contoy and Tampico grounds, with no more than 80 percent of the catch being taken off Tampico. Each vessel participating in the fishery will pay annually a permit fee of $80 and a charge of $2,006 for its yearly catch, calculated on the basis of 5 percent of the official price for shrimp (as established by Mexico) of $4,640 per ton.

Vessels that intend to fish off Contoy will pay a yearly catch charge of $1,538, since the fishery in this area has yielded, on the average, 35 percent rock shrimp. The official price for rock shrimp is $1,540 per ton.

The agreement provides for 52 U.S. vessels to participate in the hook and line fisheries within the Mexican zone until the annual allocation of 450 metric tons is taken. Each vessel will pay an annual permit fee of $80 and a charge of $433 for its yearly catch (determined by dividing the number of authorized vessels into the total charge for the amount of agreed capture which is 5 percent of the fishery's official price of $1,000 per ton times 450 metric tons).

Owners of vessels participating in either of the above fisheries will be required to make a cash deposit of performance guarantee or post a performance bond with a Mexican bonding company to guarantee compliance with the obligations. The amount of the cash deposit or bond will be $1,600 for individual vessels, or $160 for vessels applying in association with others, with joint liability for loss of the cash guarantee or bond.

Vessels authorized to fish in the shrimp or hook and line fisheries may take associated incidental fishes that do not exceed, on the average, 5 percent of the total catch.

To determine the actual harvest, the master of each U.S. vessel with a permit to fish in the shrimp or hook and line fisheries will maintain a current vessel fishing log while in the Mexican economic zone, and at the end of each trip, deliver a notarized fishing trip report to the nearest Mexican Consular office, sending a second copy of the report to the National Marine Fisheries Service, St. Petersburg, Fla.

A limited number of U.S. fishing vessels that have traditionally fished within 12 miles of the Pacific coast of Mexico will be permitted to continue fishing for the same species, generally in accordance with past practices. Mexico has authorized a list of 141 vessels that may apply for permits to fish within the 12-mile zone. Vessels that are on the list, if removed from the fishery, may not be replaced; nor can vessels remain on the list if there is a change in ownership, except in the case of transfer by inheritance of the vessel from parent to child and so long as the child operates the vessel. A vessel may be removed from the list of vessels authorized to apply for permits if it fails to fish during a period of 12 consecutive months.

Each vessel will pay an annual permit fee of $80 and a charge before each trip based on a percentage of the fishery's official price of $464 per net registered ton. The charge for vessels whose net registered tonnage is not greater than 150 tons will be 5 percent of $464, or $23.20 per net registered ton; for vessels over 150 tons, 10 percent of $464, or $46.40 per net registered ton.

Regarding highly migratory species, the U.S. Government will provide to the Government of Mexico the names of U.S. vessels which intend to fish highly migratory

Sealskin Import Permit Granted

A permit to import 13,000 Cape fur sealskins from the Republic of South Africa was issued earlier this year to the Fouke Fur Company, Greenville, S.C., by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service.

The importation will be permitted under the following conditions:

1) The skins must have been taken within the Republic of South Africa, in accordance with its laws, and by, or under, the auspices of that nation.

2) The Republic must certify that none of the skins was taken from Namibia.

3) The skins must be from an annual kill not exceeding 70,000 cape fur seals and is subject to continuing evaluation of the management program by the U.S. If more than 70,000 are killed in any one year, no skins from that kill can be imported into the United States.

4) No skins can be imported from animals that were nursing, pregnant, or less than 8 months old at the time of the taking.

5) The skins must be taken in a manner not deemed inhumane by the Director of NMFS.

Importation of marine mammals or marine mammal parts is prohibited by the Marine Mammal Protection Act of 1972. However, the Act authorizes a waiver of the moratorium when it is determined on the basis of the best scientific evidence available that the taking of the marine mammals is in accord with sound principles of resource protection and conservation.

This is the first permit granted by the Department of Commerce Agency to import South African skins under a 1975 waiver of the moratorium placed on the importation of all marine mammals and marine mammal products by the Marine Mammal Protection Act.

species in the 12- to 200-mile zone in accord with the present IATTC regime, and will transmit to the Government of Mexico on behalf of those vessels, the fees charged for issuance of certificates ($20 per vessel) indicating the status of those vessels fishing in the Mexican economic zone.

Enforcement of the agreement is the responsibility of Mexico which, under the agreement's provisions, may stop, board, and inspect any U.S. fishing vessel fishing in the Mexican economic zone when there is reason to believe such vessel is not fishing in accordance with the terms and conditions of the agreement. They may also seize and arrest U.S. fishing vessels that violate the agreement, and impose penalties, as provided by Mexican law, on U.S. fishing vessels that violate the agreement.

Vessels and their crews arrested for violation of the agreement will be promptly released upon posting of a security reasonably related to the amount of the penalty.

Agreement between the two countries was also reached to take appropriate measures to reduce incidental catches of any marine mammal and to protect endangered species.

Regulations governing recreational fishing in the Mexican economic zone are not a subject of the agreement. Licenses and permits for recreational fishing within the Mexican territorial sea and the 12- to 200-mile economic zone may be purchased at Mexican Consulates in the United States and Canada.

Outstar Jing 1975 NMFS Publications Selected

The outstanding papers authored by National Marine Fisheries Service scientists and published in the *Fishery Bulletin* and the *Marine Fisheries Review* in 1975 have been selected by the NMFS Publications Policy Board.

William E. Schaaf received a Special Achievement Award for his paper "Status of the Gulf and Atlantic Menhaden Fisheries and Implications for Resource Management." It was published in the September issue (Vol. 37, No. 9) of *Marine Fisheries Review*. Schaff is with the Atlantic Estuarine Fisheries Center, Beaufort, N.C.

Selected as the best publication in a 1975 issue of the *Fishery Bulletin* was "Systematics and Morphology of the Bonitos (*Sarda*) and Their Relatives (Scombridae, Sardini)," (Vol. 73, No. 3). It was authored by Bruce B. Collette and Labbish N. Chao. Collette is with the NMFS' National Systematics Laboratory, Washington, D.C. Chao, with the Virginia Institute of Marine Science, Gloucester Point, Va., is now at the National Museum of Natural Sciences, Ottawa, Ontario, Canada.

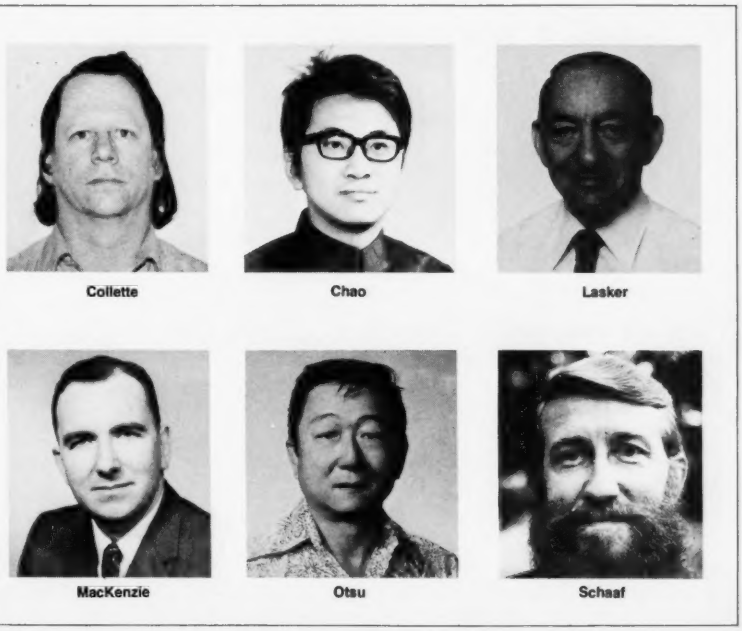
Two papers in *Marine Fisheries Review* were selected for honorable mention. They were: "Development of a Program to Rehabilitate the Oyster Industry of Prince Edward Island" by Clyde L. MacKenzie (Vol. 37, No. 3, March 1975); and "Japan's Fisheries, 1975" by Tamio Otsu, in Vol. 37, No. 11, October 1975. MacKenzie is with the Sandy Hook Laboratory, Northeast Fisheries Center, Highlands, N.J., and Otsu is with the Honolulu Laboratory, Southwest Fisheries Center, Honolulu, Hawaii.

Reuben Lasker's *Fishery Bulletin* (Vol. 73, No. 3) paper, "Field Criteria for Survival of Anchovy Larvae: The Relation Between Inshore Chlorophyll Maximum Layers and Successful First Feeding," was also selected for honorable mention. Lasker is with the Southwest Fisheries Center, La Jolla, Calif.

Developed in 1975, the annual publication awards program recognizes NMFS employees who have made outstanding contributions to the knowledge and understanding of the resources, processes, and organisms studied as part of the NMFS mission.

Fishery Bulletin papers must document outstanding original scientific work while *Marine Fisheries Review* papers must be effective and interpretive contributions to the understanding and knowledge of NMFS mission-related studies.

Any NMFS employee may recommend publications of the appropriate calendar years to the Publications Policy Board for award consideration. Authors must have been employed by the NMFS at the time the paper was published. Nominations, solicited by 1 April each year, must include the author's name, paper title and number of pages, series name and/or volume, justification to support the nomination, and the name and office affiliation of the nominator.



Japan: Butterfish and Armorhead Prices, Shrimp and Tuna Reports, EZ Threat, and a New Fisheries Chief

NEW YORK BUTTERFISH BRING HIGH PRICES

Butterfish (*Psenopsis anomala*), caught in waters off New York, have been sold in Japan at prices normally charged for a prize fish, reports the *Suisan Keizai Shinbun*. A shipment of 20 tons of butterfish by Nichiro Fishery in December was sold out in spite of the high prices charged by the firm, ranging from 15,000 yen per 20 kg ($2,322/short ton, based on 293 yen = US$1) for a large size to 13,000 yen ($2,013/short ton) for a medium size and 11,000 yen ($1,703/short ton) for a small size. The high demand for the fish has been sustained mainly because of the poor harvest from the coastal fishery around Japan. Japanese firms were reportedly planning to get additional shipments of 1,500 to 1,600 tons of butterfish in January.

PELAGIC ARMORHEAD IN HIGH DEMAND

The Japanese 4,000-gross-ton trawler *Fuji Maru*, owned by Nihon Suisan, has been fishing for kusakari tsubodai (the pelagic armorhead, *Pseudopentaceros richardsoni*) in the central Pacific Ocean off Midway Island. The vessel's catch was averaging 500 to 600 metric tons a month. The price being charged by the firm is reportedly 180 yen per kilogram (US$614/metric ton at 293 yen = US$1) on the average. Buying interest among wholesalers was very active and the inventory was reported exhausted by the *Suisan Keizai Shinbun* on 22 December 1976.

TUNA PURSE SEINER REPORTS POOR FISHING IN CORAL SEA

The Japanese tuna purse seiner *Nippon Maru* (1,000 gross tons), which is engaged in tuna surveys in the Pacific under charter to the semigovernmental Japan Marine Resources Research Center, reported zero fishing in the Coral Sea in the vicinity of lat. 9°-23°S and long. 153°-166°E during the first half of December 1976. The vessel had sought tuna near floating logs, bird flocks, and porpoise schools but had been hampered by strong winds and poor visibility. The vessel's cumulative catch up to mid-December remained 293.5 tons consisting of 123.6 tons of yellowfin, 106.3 tons of skipjack and 63.6 tons of other tuna, which represented 26.4 percent of the catch target. Sources: *Minato Shinbun* and *Katsuomaguro Tsushin*.

CARRIER VESSEL LAUNCHED

A modern 999-gross ton carrier vessel *Seiko Maru No. 18*, owned by Toei Fishery of Misaki, Japan, was launched on 21 December 1976 and was outfitted for delivery in mid-February. Equipped with a large extra-low-temperature (−50°C) storage hold and a large fuel tank, the vessel is capable of taking four full loads of a normal longline vessel and cruising for 80 days without refueling. The vessel will be used to transport high-quality tuna from the firm's 19-vessel Atlantic Ocean tuna longline fleet to Japan and is expected to cut the fleet's fuel costs substantially by reducing the number of shuttles now being made between the fishing ground and Japan by individual longliners.

The vessel's main specifications are: length overall, 70.0 meters; breadth, 12.8 meters; depth, 5.05 meters; storage capacity, 2,330 cubic meters; fuel capacity, approximately 570 cubic meters; main engine, 2,700 h.p.; and cruising speed, 13.8 knots. Source: *Suisan Keizai Shinbun*.

SOLOMON ISLAND, PNG SKIPJACK CATCH RECORDS

The Japanese skipjack fishery based on the Solomon Islands and Papua New Guinea was generally good for 1976. Solomon Taiyo, a joint venture based in the British Solomons, which operates one mothership and 14 pole-and-line skipjack vessels led all other firms with a catch record of over 15,000 tons for the year. Gollin Kyokuyo, a joint venture between Kyokuyo Fishery and Australian interests based in Kavieng, came in second with 14,000 tons, followed from far behind by Carpenter Kaigai whose catches ended in the 8,000-ton level. The monthly breakdown of catch record is shown (right) from *Suisan Tsushin*.

MORE TUNA PURSE SEINERS FOR SOUTH PACIFIC

Japanese firms are showing signs for increasing the tuna purse seiner fleet in the South Pacific, reports the *Shin Suisan Shinbun*. Kyokuyo Fishery has announced a plan to build two 500-gross-ton purse seiners, and one is scheduled to enter construction late this spring. Two other firms reportedly have plans to build a tuna purse seiner each.

FRENCH GUYANA'S 200-MILE DECREE WORRIES SHRIMPERS

An expected decree by the French Government establishing a 200-mile economic zone off French Guyana as of 1 January has caused grave concern to the Japanese shrimp industry which maintains 84 shrimp vessels in this area, taking 2,500 tons annually. The industry fears that whereas the economic zone would result in a loss of 35 percent in quantity of its total annual shrimp catch off French Guyana, the loss in value would amount to as much as 60-70 percent owing to the high market value of the pink shrimp being fished in this area. The industry is also concerned that its joint ventures in Guyana and Surinam, representing a 1.1 billion yen ($3.8 million) investment so far, could face a shutdown as a result of the economic zone decree. Source: *Nihon Suisan Shinbun*.

YELLOW, EAST CHINA SEA LANDINGS THREATENED

The Japanese Fisheries Agency estimates that Japan's fish catch in the Yellow and East China Seas would drop 50 percent

Japanese skipjack catches off the Solomon Islands and Papua New Guinea, 1976.

Month	Catch in metric tons		
	Solomon Taiyo	Carpenter Kaigai	Gollin Kyokuyo
January	89	260	
February	447	64	
March	635	188	383
April	937	396	1,515
May	1,608	879	1,881
June	2,110	1,183	2,096
July	2,150	706	1,782
August	1,448	1,240	1,432
September	1,865	854	1,873
October	1,845	1,796	1,998
November	1,479	796	1,236
December[1]	649	146	191
	15,292	8,508	14,385
Motherships	1	2	2
Pole-and-line vessels	14	11	11

[1]As of 15 December.

should China and Republic of Korea establish a 200-mile economic zone. Japanese fishermen are currently taking 650,000 tons of fish in these areas, of which 130,000 tons comes from inside 200 miles off China and 150,000 tons from inside 200 miles off Republic of Korea. Source: *Suisan Keizai Shinbun*.

NEW AGRICULTURE AND FORESTRY MINISTER CHOSEN

The newly formed Japanese Government under Prime Minister Takeo Fukuda named Yoshiyuki Suzuki to Minister of Agriculture and Forestry. The Ministry has the Fisheries Agency under its jurisdiction. Suzuki, an influential member of the ruling Liberal Democratic Party, has served 12 terms in the Diet since 1946 and held ministerial positions in previous cabinets. A graduate of Miyako Fishery School and Fishery Academy (Suisan Koshujo), Suzuki has long been a key figure in the Japanese fishery circle, reports the *Suisan Keizai Shinbun*.

Nicaragua Tells License Rules for Foreign Fishermen

Nicaragua's marine fishing industry is still in its infancy. Commercial fishing is primarily based on lobster and shrimp, which are mostly frozen and exported to the United States. Tuna will soon become, however, another major export commodity.

The "Special Law for the Exploitation of Marine Resources and the Reforms" of 1961 and the "General Law on the Exploitation of Natural Resources" of 1958, govern commercial fishing in Nicaraguan waters. Fishing by U.S. firms appears to be governed by the 1956 "Treaty of Friendship, Commerce, and Navigation" between Nicaragua and the United States. Article XI of that Treaty provides, inter alia, that ". . . nationals and companies of either party engaged in trade or other gainful pursuit . . . shall not be subject to the payment of taxes, fees or charges . . . more burdensome than

those borne by nationals and companies of such other party." Commercial U.S. fishing firms are believed to enjoy equal status with Nicaraguan companies. U.S.-Nicaraguan joint ventures dominate the local seafood export business, and fishing companies of other countries are not believed to have obtained fishing licenses or concessions in Nicaragua.

According to the Special Law of 1961 the Nicaraguan Government does not charge for commercial fishing licenses. Holders of such licenses, however, must pay an annual tax based on the size of the vessel used. The current rate is US$10 for vessels less than 16 feet long. Longer vessels pay an additional US$1 for each additional foot. Commercial fishermen must also pay a tax on their net profits, ranging from 3 percent on profits not exceeding 15 percent of sales, to a 0.4 percent tax on each percentage of profit exceeding 30 percent of sales. However, since all commercial fishing firms apply for and receive concessions under the industrial development law, no fishing companies are presently paying this profit tax.

Commercial fishing licenses are valid for an initial period not to exceed 20 years and can be renewed for 10 additional years. Commercial fishing is under the jurisdiction of the Ministry of Economy whose Directorate General of Natural Resources issues

Russia, Spain Continue Fisheries Involvement

After completing an important plant in the Canary Islands harbor of Las Palmas, the Spanish-Soviet joint fishing company Sovhispan has started the construction of a second plant in the harbor of Teneriffe for an investment of 100 million pesetas ($1,500,000), according to a *La Peche Maritime* report. The new installations will service 1,500 fishing vessels—in effect the Soviet Atlantic fishing fleet which will concentrate its activities in Teneriffe. The new plant will have a processing capacity of 5,000 t of fish per year.

Sovhispan is constituted as follows: 50 percent of its capital is invested by Sovrybflot, overseas commercial organization of the Soviet Ministry of Fisheries, 25 percent by Compania General de Tabacos de Filipinas of Barcelona, and 25 percent by Suardias Chartering S.L. of Madrid. The major part of its capital is invested in an enterprise employing Spanish and Soviet vessels and processing and selling fishery products; 50,000 t were sold in 1975.

In 1975, Sovhispan founded with Sieisa of Madrid a branch, Pesconsa, for searching new fishing grounds. Pesconsa is trying to introduce new techniques in the fishing industry; that's why Spanish vessels are equipped with Soviet cold storage systems. At the beginning of February 1976, Spain received 10 medium trawlers from the USSR. In 1975, 160 Soviet vessels have been overhauled in the Sovhispan shipyards. In 1976, Sovhispan delivered to the USSR 50 million cans of canned fish made of Soviet metal. In 1975, the output amounted to 10 million cans.

Germans Give Krill Harvesting Results

The German Federal Fishery Research Board has released further details concerning the Government-financed krill research expedition to Antartica which took place during the first half of 1976.

The Board recently published its findings on the vertical movement of juvenile krill which indicated that during daylight hours, good hauls (over 30 t per hour) were possible only if large and dense krill concentrations were detected by sonar. When single krill schools moved at varying depths, however, it was often impossible to direct accurately the catching gear at a particular swarm because of the relatively short distance between the ship and the trawl net.

When the krill started moving to greater depths at the break of dawn, catching operations were discontinued because they were unproductive. The results indicate that krill harvesting will yield optimal results between 4 p.m. and 3 a.m. (Source: U.S. Consulate General, Bremen.)

licenses to those who already have, or who promise to construct, within a reasonable period, one or more shore-based plants having sufficient capacity to process fishery products for export. The Ministry may also authorize the temporary use of vessels capable of processing the catch at sea. In addition to fishing licenses, a fishing permit for each vessel must be obtained annually from the Directorate General.

The Special Law does not limit the size of commercial fishing vessels or reserve specific fishing grounds for domestic fishermen. The Ministry of Economy, however, does have the authority to limit the number of licenses which it issues and the number and size of vessels permitted to operate on a given fishing ground. The Special Law also prohibits the use of poisons and explosives to fish.

Violators of the provisions of the Special and General Laws can be subjected to fines of up to 10,000 cordobas (US$1,430), which can be doubled for subsequent infractions. Violators also face possible revocation of fishing licenses.

In October 1976, Nicaraguan customs officials arrested the captains and crews of two Costa Rican vessels for alleged illegal fishing in Nicaraguan territorial waters. Customs reportedly confiscated their fishing gear as well. This incident was presumably in retaliation for the earlier detention by Costa Rican authorities of Nicaraguan fishermen and vessels on similar charges. The U.S. Embassy in Managua reports that the two governments are currently negotiating a reciprocal fishing rights treaty. Source: U.S. Embassy, Managua.

World Fisheries Developments Reported

The Branch of International Fisheries Analysis, which follows trends in world fisheries for the National Marine Fisheries Service (NMFS), has prepared the following summary of the recent significant action in world fisheries.

WORLD FISHERY JURISDICTIONS

Bulgaria and the United States signed a Governing International Fisheries Agreement on 18 December. The agreement regulates Bulgarian fishing in U.S. waters for the 5-year period that began on 1 March.

Canada set an Arctic 200-mile fisheries zone on 1 March. Although there are no existing commercial fisheries in the area nor any depleted stocks requiring conservation measures, the Canadian Government believes the extended zone will safeguard the future potential for development of fisheries in the Arctic.

The Pakistani Government introduced a bill in the National Assembly on 16 December to extend that country's exclusive economic zone to 200 miles. The bill was passed on 17 December and was to become effective after its expected ratification by the Pakistani Senate.

The Federal Republic of Germany, on 23 December, formally proclaimed the extension of its fishing zone to 200 nautical miles. The extension became effective on 1 January and was in accord with a joint decision to extend fishery jurisdictions reached last November by the nine members of the European Economic Community (Common Market).

The Economic Community (EC) Council of Foreign Ministers was unable to agree, during its 20 December session in Brussels, on an interim fishing regime inside its 200-mile fishing zone (which became effective 1 January). Faced with dissent among EC members, the Ministers announced on 21 December that EC member states may catch in January 1977 only the amounts of fish caught in January 1976. This ad hoc agreement was to be rediscussed at a later meeting.

The Irish Foreign Minister told the press that the decision of EC Foreign Ministers to temporarily "stop the clock" would not apply to Ireland and that the Irish catch for January 1977 could be increased. The EC Council of Foreign Ministers on 30 October agreed that Ireland could double its fishing capacity by 1979.

Britain's fishing fleet was unable to enter Icelandic waters on 1 January as the British Government hoped, because Iceland refused to negotiate an agreement with EC. The United Kingdom is opposed to "negotiations by threat," according to the U.K. Minister of State during a Brussels press conference.

Norway's extension of fisheries jurisdiction to 200 miles, effective 1 January was finalized by a Royal Decree dated 17 December 1976. The rights of navigation or overflight are not affected and where the Norwegian zone meets the jurisdiction of another state, the limit shall be drawn by agreement. The Decree prohibits foreign fishing inside the extended zone, except as allowed through bilateral agreements. The Decree contains no reference to the Svalbard (Spitzbergen) Islands.

Norway has signed bilateral fishery agreements with the following countries: Canada (2 December, 1975), Iceland (10 March 1976), Spain and Sweden (9 November 1976), and the USSR (16 October 1976). More recently, Norway has been conducting negotiations with the EC regarding reciprocal fishing rights.

Norwegian Foreign Minister Knut

Canada Puts $5 Million Into Fishing Harbors

By the end of March 1977 Canada spent $5 million on the restoration of, and additions to, commercial fishing harbors across the country under the auspices of the Federal Labour Intensive Program (FLIP), Fisheries Minister Roméo LeBlanc reported. In accordance with FLIP objectives, most of the work took place in high unemployment areas, and it was estimated that the various projects provided employment for close to 1,000 people over the winter months.

The $5 million expenditure, administered by the Small Craft Harbours Branch of Fisheries and Environment Canada, was spread over approximately 150 projects. Work included repairs to wharves and breakwaters, demolition of facilities no longer in use and considered hazardous to the public, and construction of ancillary facilities to wharves, such as canopies. More than half of the money was spent on projects in Newfoundland and the Maritime provinces, however, all other provinces reportedly benefited from the program.

Krydenlund reasserted Norway's authority over the Svalbard Islands in a foreign policy address on 13 December 1976. The Soviet Union also has claims in the area, especially those concerning fishing and oil extraction. The Norwegian Minister stated that although friendly relations with the USSR will be maintained, fishery and mineral questions must be settled through negotiation.

Norway and Portugal signed a bilateral fisheries agreement on 21 December 1976, under which the Portuguese fleet will be allowed to fish between 50 and 200 miles inside the Norwegian fishing zone. The agreement will remain in force until 1980. Fishing quotas for the Portuguese fleet will be set later.

Portugal's Socialist Party presented a bill to the National Assembly which would establish a 200-mile economic zone for Portugal. The socialists are the majority party in the Government coalition.

Poland and the German Democratic Republic have both signed agreements with Norway on their fishing inside Norway's 200-mile limit. The Polish agreement was signed on 10 December and the GDR agreement on 15 December.

ASIA

Japanese Government and fishing industry circles were reportedly shocked by the Soviet Union's declaration of a 200-mile exclusive fishing zone on 10 December 1976. Access to waters adjacent to the Soviet Pacific coastline is essential to Japanese fishing operations. There was concern that the Soviet decision might lead to similar moves by South Korea and the Peoples' Republic of China.

Republic of Korea pollock and cod fisheries in the north Pacific may be threatened by the Soviet Union's decision to extend its fisheries jurisdiction to 200-miles on 1 January. Approximately 70 percent of the South Korean Alaska pollock catch originates in the waters off Kamchatka.

A new "Association to Promote the Japanese Fisheries" was organized in Tokyo on 4 November at a meeting attended by the President of the Japanese Fisheries Association, former Ministers Oishi and Kosaka, and 300 representatives of the industry. The new organization reportedly will help the industry in responding to current pressures.

Japan and the Soviet Union on 13 December agreed on how to divide the 1977 sperm whale catch given up in the Southern Hemisphere by South Africa. Japan's quotas will increase from 168 to 238 males and from 37 to 63 females and the Soviet ones from 2,842 to 3,134 males and from 600 to 707 females.

Seychelles Islands and France are examining the possibilities of a joint venture to develop the newly-independent island's fishery resources. Until now, the Seychelles' fishermen only fished in coastal waters. The French hope to develop a profitable tuna fishery.

Operations of Thai fishermen in the Indonesian archipelago were discussed in a joint Thai-Indonesian communique issued 12 December following the visit of Thailand's Prime Minister to Indonesia. Fisheries cooperation between the two countries is under consideration.

India and the Philippines signed a protocol in November promoting cooperation in farming research which will include studies on inland fish culture.

RUSSIA

The Soviet Union hopes to establish a fishing base in Western Samoa, which is located just 80 miles from American

CANADA-FRANCE OK FISHERY ARRANGEMENT

The Canadian Secretary of State for External Affairs, Don Jamieson, and the Minister of Fisheries and the Environment, Romeo LeBlanc, have announced that Canada and France have agreed on interim fisheries arrangements, following extension of jurisdiction by Canada and France to avoid difficulties in enforcement of fisheries regulations off the islands of St. Pierre and Miquelon, pending a boundary settlement.

Following consultations between Jamieson and the Foreign Minister of France, Louis de Guiringaud, in Paris on 3 November 1976, and subsequent discussions between officials of the two countries in Ottawa on 25 and 26 November, the two governments have agreed to exercise restraint in the application of their fisheries regulations to each others' vessels in a stock management area, Division 3PS, of the International Commission for the Northwest Atlantic Fisheries (ICNAF). Enforcement by the two countries vis-a-vis Canadian and French vessels will be based on the ICNAF International Enforcement Scheme. Fisheries in this area will continue to be managed for 1977 in accordance with the regulations adopted by ICNAF. These arrangements are without prejudice to negotiations respecting the limits of maritime jurisdiction in this area.

The two governments have stressed their commitment to cooperation on fisheries in the area and to pursuing negotiations on the establishment of boundaries. Jamieson and LeBlanc have expressed their satisfaction with these arrangements, which reflects the longstanding spirit of cooperation in Canada-France fisheries relations. (Source: Press release Department of External Affairs, Ottawa.)

U.S.–USSR Sign Fisheries Agreement

Representatives of the Union of Soviet Socialist Republics and the United States of America on 26 November 1976, signed a new agreement relating to fishing activities of the Soviet Union off the coasts of the United States, the U.S. Department of State reports.

The agreement set out the arrangements between the countries which will govern fishing by the Soviet Union within the fishery conservation zone of the United States. The agreement was to enter into force after the completion of internal procedures by both governments.

Vladimir M. Kamentsev, First Deputy Minister of Fisheries, USSR, signed for the Union of Soviet Socialist Republics. Ambassador Thomas A. Clingan, Jr., Chairman of the U.S. Delegation, signed for the United States.

Both delegations expressed their satisfaction with the new accord, and the hope that it will contribute to mutual understanding and cooperation between the two governments.

Samoa. The Samoan Government is still considering the Soviet proposal. The offer was also made to the Kingdom of Tonga, a small island nearby.

LATIN AMERICA

The Peruvian Fishermen's Federation which declared a strike on 18 October, ordered its members back to work on 11 December.

Peru's Government-owned fish meal company, PESCAPERU, has sold 85 percent of its fleet of 451 anchovy seiners. Fishermen, who have formed partnerships, and small companies have purchased most of the vessels, but some were also bought by their former owners. The fish meal plants remain state-owned enterprises.

Peruvian anchovy could be canned for human consumption at a cost of about $700 per t (metric ton), according to a recent FAO study. Due to the decline of the bonito fishery, Peru has a large unused canning capability.

Brazilian scientists are conducting biological research on tuna, marlin, and swordfish caught by that country's longline fleet. In addition, a program of exploratory fishing using live bait has begun off northeast Brazil.

Brazilian longliners, operating off that country's southern coast, caught 1,130 t (gilled and gutted) of tuna and tuna-like species in 1975, or 10 percent more than in 1974.

Brazilian and Venezuelan fisheries will be studied by the London-based AFP Consulting Group to assess export possibilities for U.K. companies.

Ecuadorian shrimp exports to the United States were a record 3,300 t during the first 9 months of 1976, an increase of 11 percent over the more than 2,900 t exported during the same period in 1975.

Mexico delivered three of the four shrimp trawlers purchased by the Indian State Government of West Bengal. The trawlers have a carrying capacity of 6 t of shrimp and are scheduled to begin fishing in March 1977 from the port of Roy Chowk where a $560,000 shore complex is under construction. .

Mexican shrimp exports to the United States were 18,600 t during the first 9 months of 1976, a decline of 7 percent from the 20,000 t exported during the same period in 1975.

The Panamanian Government has selected two Japanese construction companies, Aoki and Rinkai, to build the first stage of the new Vacamonte fishing port. The contract is worth about $30 million.

Colombia and Panama signed a Convention in Cartagena on 20 November 1976 delimiting their marine boundary. Colombia signed a similar agreement with Ecuador in 1975.

EUROPE

British cod wholesalers and processors are seeking supplies of frozen cod blocks throughout Europe and are reportedly offering over US$0.90/lb. The cod shortage is caused by the expiration of the temporary fisheries agreement with Iceland which allowed the British to fish within the Icelandic 200-mile fishing zone until last December.

Spanish wholesalers were paying from US$1.25 to 1.40 for 1 kilogram of Boston squid (*Loligo*) and from $0.62 to 0.78 for summer squid (*Illex*) late last year.

The Federal Republic of Germany has developed an oceanographic research and technology program covering the period 1976-1979, with an estimated cost of US$408 million. The program will emphasize the control of marine pollution, development of marine food resources, and the exploration of mineral deposits.

Foreign Fishery Reports and Leaflets Available

The NMFS Office of International Fisheries has compiled statistical data on Taiwan's fisheries catch by species, and by type of fishery (high-seas, outer coastal, inner coastal, and fish culture) for July 1976. The statistical data included in the two tables are: monthly catch (current & previous year) in metric tons, and quantitative change, as well as percentage change from the previous year.

Anyone interested in receiving a copy of the above monthly statistical tables should write to the Division of International Fisheries Analysis (F41), Office of International Fisheries, NMFS, NOAA, Commerce Department, Washington, DC 20235. Please enclose a self-addressed label to facilitate mailing.

The Office of International Fisheries also has a limited supply of a number of Foreign Fisheries Leaflets. Requests will be honored as long as the supply lasts. Send your requests (plus the self-addressed label) to the address given above.

Leaflets still available include: FFL 74-12, Fisheries of the Cameroons, 1973; FFL 74-9, Fisheries of Tanzania, 1972; FFL 74-5, Fisheries of Kenya, 1973; FFL 74-3, Fisheries of The Gambia, 1973; FFL 74-1, Fisheries of Pakistan, 1972; FFL 73-21, Fisheries of Chile, 1971; FFL 72-6, The Commercial Fisheries of Portugal, 1970; FFL 72-11, Thailand Fishery Trends; FFL 70-13, India Seafood Industry's New Export Record; FFL 70-120, The Fisheries of The Democratic Republic of The Congo; Fisheries of the Republic of Korea; Persian Gulf Fisheries; The Commercial Shrimp Potential in West Africa Dakar to Douala; A Review of The Indonesian Shrimp Fishery and its Present Developments; Shrimp Industry of Central America, Caribbean Sea, and Northern South America; FFL 75-1, Fisheries of Panama, 1973; FFL 75-2, Fisheries of Denmark, 1974; FFL 76-1, Fisheries of the Malagasy Republic, 1974; and IFL 76-182, Peruvian tuna industry.

CHARTS SHOW CANADA'S 200-MILE FISHING ZONES

Canada's 200-mile fishing zones, which went into effect on 1 January are officially in place on four new navigation charts issued by the Department of Fisheries and the Environment.

The limits of the zones are set out on three new East Coast charts: #4001 (Gulf of Maine to Strait of Belle Isle); #5001 (Strait of Belle Isle to Hudson Strait); and #7010 (Davis Strait and Baffin Bay). On the Pacific Coast the 200-mile zone is indicated on a single chart, #3000 (Juan de Fuca Strait to Dixon Entrance).

The new charts, $3 each, are available from chart dealers across the country or from the Marine Chart Distribution Office, Canadian Hydrographic Service, DFE, 1675 Russel Road, Ottawa, K1G 3H6.

Pacific Coast Latin American Licensing Regulations Told

All Pacific coast Latin American countries, except Honduras and Colombia, have claimed 200-mile limits. The exact nature of these claims and the licensing regulations implemented for foreign fishermen varies from country to country. The U.S. Embassy in Quito has prepared a brief resume of the licensing regulations of a number of Pacific coast Latin American countries (Table 1). The cost of the licenses varies from $20 per net registered ton in Peru to $60 per net registered ton off Ecuador and Chile. The duration of the licenses also varies from Costa Rica's limit of 60 days to 20 years in Nicaragua.

Table 1.—Fishing regulations of west coast Latin American countries.

Country	Price charged foreign vessel for commercial fishing license	Duration of license	Procedures for obtaining license	Foreign fishing vessel size limit	Limitation on type or mode of fishing	Zone reserved exclusively for domestic fishing vessels	Penalties for commercial fishing without valid license	Other relevant policies and practices
Chile	US$60 per net registered ton	Not available	Not available	None	Licenses only granted for fishing south of 40° and west of 74°W between 37° and 40°S.	None	Payment of fine equal to $120 per net registered ton.	$20 per ton of fish must be paid as a tax.
Colombia	100-200 pesos per gross registered ton for firms domiciled in Colombia; 2,000 pesos for others.	If domiciled in Colombia, 1 year (and one ocean); otherwise 30 days (and one ocean)	Must be obtained from the National Institute for the Development of Renewable Natural Resources.	None	Shrimp fishing is temporarily banned and lobster fishing is regulated. Foreign nationals not legally domiciled in Colombia may fish only for cetaceans, tuna and live fish bait.	None	Not available	
Costa Rica[1]	US$30 for vessels up to 400 tons; $60 for vessels over 400 tons	60 days	Not available	None	Vessels using live bait or harpoons instead of nets granted 50% fee reduction	None	Not available	Foreign vessels of less than 400 tons which sell at least 100 tons of catch to domestic canneries granted free extension of permit. Foreign vessels under contract to domestic company given same treatment as national flag vessel.
Ecuador	US$60 per net registered ton[2]	1 "voyage" (60 to 90 days depending on where license is obtained)	Must be obtained from Directorate General of Fisheries or from Ecuadorean Consulate. Permission to fish granted by radio.	None	Use of poisons and explosives prohibited. Foreigners not allowed to fish for lobster or shrimp.	60 miles[2]	Payment of fine equal to $120 per net registered ton and confiscation of catch for first offense; increased for further violations.	Ships operating under association agreements must sell 20% of their catch in Ecuador.
El Salvador[3]	Not available, but will be based on net registered tonnage of vessel.	Not available	Must be obtained from Department of Industrial Development and Control or from Salvadorean Consulate	None	Not available	1st 12 miles: only Salvadoreans or companies at least 50% Salvadorean-owned. 12-60 miles: only companies domiciled in El Salvador.	Payment of fine equal to US$80 per net registered ton; possible further punitive action.	
Guatemala	US$40 if vessel has net weight of less than 50 tons; $60 for vessels between 50 and 100 tons; $160 for vessels greater than 100 tons[4]	1 year	Must be obtained from Ministry of Agriculture	None	Use of poisons and explosives prohibited. No licenses issued for Pacific shrimp fishing.	None	Seizure of fishing gear, confiscation of catch, and $10,000 fine	Ship must pay $10 per ton fish storage capacity each time it puts out to sea from a Guatemalan port.
Mexico	US$1,600 cash deposit of performance guarantee for tuna boats and shrimpers[5]	Variable	Must be obtained from Mexican Fisheries Office or from Mexican Consulate	None (but *number* of vessels limited by U.S.-Mexican Executive Agreement)	Purse seine net size limited by Executive Agreement. Long-line tuna fishing prohibited.	None	Confiscation of catch, plus fine	Catches of shrimp and tuna limited by tonnage
Nicaragua	US$10 for boats up to 10 feet in length; $1 additional for each foot in excess of 16 feet[6].	20 years[7]	Must be obtained from Directorate General of Natural Resources	None (but number of licenses and number and size of vessels exploiting a given fishing area may be limited)	Use of poisons and explosives prohibited	None	Payment of $1,400 fine (doubled for subsequent violations), possible revocation of fishing license, and possible confiscation of fishing gear.	Fishing licenses are only issued to persons or corporations who have or promise to establish fish processing plants in Nicaragua.
Panama	US$30 per net registered ton	6 months	Must be obtained from Marine Resources Office	None	None	None	Vessels serving domestic market must pay fine of up to $1,000. Vessels serving external market must pay fine of $10,000-$100,000.	Vessel may be confiscated for repeated violations. Vessel must have agent in Panama.
Peru	US$20 per net registered ton	100 days[8]	Must be obtained from Ministry of Fisheries or from Peruvian Consulate	None	Use of poisons and explosives prohibited. Foreigners not allowed to fish for anchovies.	None (but Ministry of Fisheries has authority to establish limits)	Payment of fine equal to $80 per net registered ton for first offense; increased for further violations.	Foreign commercial fishing vessel must have agent in Peru.

[1]Based on draft law; refers only to tuna fishing.
[2]Waived for foreign ships under association agreements.
[3]Limited information based on draft law.
[4]License information refers to Type C License required for foreign vessel discharging catch in non-Guatemalan port.
[5]No foreign shrimp fishing takes place on the Pacific Coast and the deposit does not pertain to the high seas tuna fleet.
[6]In addition, an exploitation tax must be paid, but it is usually waived under the Industrial Development Law.
[7]In addition, a fishing permit for each boat must be obtained each year.
[8]Waived for foreign ships under contract to Peruvian companies and selling entire catch in Peru.

Great Lakes Fishery Catch, Value Listed

The 1975 catch by U.S. and Canadian Great Lakes commercial fishermen amounted to 101.1 million pounds and was down nearly 25 million pounds or 20 percent from the exceptionally high total of 126 million pounds in 1974. Both the U.S. and Canadian catches—60.7 and 40.4 million pounds, respectively—were lower than the previous year, although the landed value of the 1975 Canadian harvest reached a record high of $9.6 million. For the United States, the ex-vessel value of the 1975 catch was $9.0 million compared to $10.5 million in 1974. These findings and those that follow are derived from a Great Lakes Commission analysis of final 1975 catch statistics compiled by Ontario's Ministry of Natural Resources and the Great Lakes Fishery Laboratory, U.S. Fish and Wildlife Service, in Ann Arbor, Mich.

A major factor in the 1975 U.S. production decrease is attributable to the Lake Michigan alewife harvest which went from a record level of some 45.5 million pounds in 1974 to 35.2 million in 1975, a drop of 22.7 percent. However, in addition to this decline of some 10.3 million pounds, most of the other prominent species in the U.S. catch also contributed to the overall decrease of 17 million pounds in the 1975 catch (see tables on next page). For the Great Lakes states, the extent of the 1975 catch by commercial fishermen in the jurisdictional waters of each was as follows (in thousands of pounds): Illinois, 240; Indiana, 199; Michigan, 12,009; Minnesota, 1,213; New York, 600; Ohio, 7,305; Pennsylvania, 313; and Wisconsin, 38,781. The alewife portion of the catch was: Illinois, 27; Indiana, 12; Michigan, 3,678; and Wisconsin, 31,498.

In Canada, the drop of nearly 8 million pounds in the lakes commercial catch from 1974 to 1975 was primarily due to declines in the Lake Erie production of yellow perch and of such low-value species as alewives, shad, and others used for animal food. Most of the other species in the Canadian catch, however, showed moderate increases in production or remained about the same as in 1974.

The data in the accompanying tables provide a summary of the weight and dollar value of the catch by commercial fishermen during the past two years for each of the Great Lakes and for the principal species caught in U.S. and Canadian waters. Some of the specific features and developments which have had noteworthy roles in the status of the fisheries in the several lake basins are indicated below.

LAKE MICHIGAN

Landings in the four states bordering this lake totaled 45.3 million pounds in 1975, down some 14.3 million pounds or 24 percent from the previous year but continuing to account for about 75 percent of the U.S. Great Lakes catch, by weight, and for half the value of the eight-state total. This disparity between weight and value for Lake Michigan's share of the total U.S. landing relates in large measure to the continuing predominance of the low-value alewife in the lake's production. The 35.2-million-pound harvest of this species in 1975 represented 72 percent of Lake Michigan's total in terms of weight, but the landed value of the alewives was less than 9 percent of the dollar receipts from the total catch. Indications are that the decrease of more than 10 million pounds in production of this species in 1975 was prompted by lake ice conditions in the spring and by a lower market demand rather than by a declining alewife population. This small, low-value fish is used for fish meal, oil, and in pet foods.

The 1975 catch of fish other than the alewife totaled 10.1 million pounds which was 4.0 million lower than the previous year. While lake whitefish landings remained virtually unchanged at 3.4 million pounds, the chub catch of 924,000 pounds was some 2.3 million below the 1974 figure. The markedly diminished chub yield is in part due to a decrease in the population of this species which has been declining since 1968 and also results from measures being initiated by the Lake Michigan states to sharply reduce the commercial catch of chubs. Another of the lake's high-value species is the yellow perch, and the 1975 production of 800,000 pounds was down 500,000, or 39 percent from 1974. Noteworthy is the $2.5-million landed value of the lake whitefish which accounted for 54 percent of the Lake Michigan fishermen's dollar receipts in 1975 and for over one-fourth (27 percent) of the value of the total U.S. Great Lakes catch.

LAKE ERIE

The Canadian-U.S. production of 39.0 million pounds last year was 9.5 million lower than the aggregate figure in 1974. As indicated in the accompanying table, a large share of the loss was in the Canadian portion of the Erie fishery which accounted for about 78 percent of the lake's total catch and also for 75 percent of Canada's Great Lakes production in 1975. Smelt and yellow perch continue as the principal species landed by the north shore commercial fishermen, but the yellow perch catch of 8.2 million pounds was 4 million below the 1974 total and down nearly 10 million pounds from 1973. Also contributing to lower Canadian production last year was the sharp decrease in low-value species such as shad, alewives, and others used for animal food; taken as a group, the harvest for 1974 and 1975 fell from 7.7 to 2.1 million pounds.

The four-state U.S. catch was about 8.5 million pounds in 1975, down 1.3 million (14 percent) from the previous year and less than 600,000 pounds above the all-time low of 1972. The principal species accounting for the 1974-75 drop were white bass, from 2.9 to 1.7 million pounds, and yellow perch, from 2.4 to 1.9 million. About 46 percent of the 1975 U.S. production in Erie came from the small western section of the lake which included Michigan landings of 500,000 pounds and about 3.4 million of Ohio's 7.3-million-pound total.

LAKE HURON

Total 1975 landings for the lake was 5.2 million pounds with U.S. (Michigan) production accounting for 36 percent of this weight and for 26 percent of the landed value. A moderate increase in the U.S. catch from the record low in 1974 was prompted by a gain in lake whitefish landings, this species being the highest in dollar value for both U.S. and Canadian fishermen. Chubs and yellow pickerel or walleyes are also important high-value species in the Canadian catch for Lake Huron, which includes Georgian Bay and North Channel, but their production is nil in Michigan waters due to state regulations limiting the areas of commercial operations.

LAKE SUPERIOR

The total catch of 8.5 million pounds in 1975 was 1.5 million below the previous

year and was primarily the result of a drop in Minnesota's smelt landings of about 1.2 million pounds. While production in Canadian waters was below the peak reached in 1974, the landed value of the catch exceeds the $1 million mark for the first time.

	Thousands of pounds		Thousands of dollars	
	1974	1975	1974	1975
U.S. total	77,673	60,660	10,504	9,046
Lake Ontario	332	233	117	98
Lake Erie	9,849	8,486	2,087	1,964
Lake Huron	1,718	1,858	464	630
Lake Michigan	59,720	45,348	6,243	4,562
Lake Superior	6,054	4,735	1,594	1,792
Canadian total	48,363	40,428	8,404	9,609
Lake Ontario	2,364	2,777	506	782
Lake Erie	38,686	30,549	5,634	6,009
Lake Huron	3,371	3,334	1,412	1,806
Lake Superior	3,942	3,769	852	1,011
U.S.-Canadian total	125,736	101,088	18,908	18,655

	Thousands of pounds		Thousands of dollars	
	1974	1975	1974	1975
U.S. total	77,673	60,660	10,504	9,046
Leading species total	73,097	56,218	9,507	7,686
Alewives	45,556	35,216	643	406
Carp	7,058	6,733	396	330
Whitefish	4,369	4,516	3,182	3,030
Yellow perch	3,951	3,037	1,489	1,545
Smelt	4,358	2,573	194	255
Chubs	4,887	2,444	2,837	1,629
White bass	2,918	1,699	766	491
Canadian total	48,363	40,428	8,404	9,609
Leading species total	37,035	33,989	7,262	8,306
Smelt	16,902	17,333	962	1,202
Yellow perch	13,366	9,419	4,246	4,387
White bass	2,356	2,580	406	709
Lake herring	2,135	2,205	390	426
Chubs	980	1,249	460	771
Whitefish	1,296	1,203	798	811

LAKE ONTARIO

U.S.-Canadian production was 3 million pounds in 1975 with about 92 percent of this weight total caught in Canadian waters. There are only two U.S. commercial fishing operations, both based at the east end of the lake. The combined harvest of yellow and white perch from the lake last year totaled nearly 1.1 million pounds. Nearly all the Great Lakes catch of white perch and also eels is taken in Lake Ontario, and for each of these species the 1975 total was about 400,000 pounds. (Source: *Great Lakes News Letter.*)

Maryland Seeks Help for Anadromous Fish

The Mid-Atlantic Fisheries Management Council has recommended that a fish ladder be built at Conowingo Dam to open up traditional spawning areas for shad, herring and other anadromous species of fish, according to the Maryland Department of Natural Resources. The council was established under terms of the Offshore Fisheries Conservation and Management Act of 1976.

Since the shad and herring fisheries of the Atlantic are dependent upon spawning success in the Susquehanna and other such rivers and streams on the east coast, the council is concerned over the blockage of breeding areas by power company dams. The council voted 15-3 late last year to instruct its execu-

Icy Winter Hurts South Carolina's White Shrimp

"We found no live shrimp anywhere," said biologist Charles H. Farmer about winter shrimp surveys by South Carolina's Wildlife and Marine Resources Department. Farmer, head of the Marine Resources Division's Crustacean Management Program, said that the prolonged cold spell of a 6-week period in January and February had a drastic effect on the white shrimp that spend the winter along the South Carolina coast.

Since these same shrimp are thought to make up a substantial portion of the commercial shrimp crop of May and June, Farmer predicts a sharp decline in the white roe shrimp harvest during the early part of the season. Last year's commercial catch of shrimp in May and June totaled 658,000 pounds, worth almost $2.5 million to the industry. This spring, said Farmer, the opening of the season could be delayed to protect the few spawning shrimp that might remain. The white shrimp that spawn in the spring produce the fall crop of white shrimp.

"Only a relatively few spring spawners are necessary to produce a normal fall population," according to Farmer, "but we may have already reached the critical point." During a recent week-long survey of shrimp from Winyah Bay to Hilton Head, Farmer was unable to locate a single live shrimp, either inshore or offshore.

A water temperature of 47°F, over an extended period of time, is considered critical to the survival of shrimp, said Farmer.

Since early January, water temperatures along the South Carolina coast have consistently remained between 41° and 45°F. Even if the weather warmed up, Farmer believed that it would have little effect on shrimp populations. "The damage is already done," he said.

During a normal year some white shrimp may migrate into the state from Georgia, but since northern Georgia has suffered similar conditions of very cold water this winter with a subsequent reduction in white shrimp, Farmer expects no relief from that area. One bright spot for commercial shrimpers is that brown shrimp, which make up the majority of the catch during June, July, and August, have not been hurt by cold winters in the past.

tive regional director to write the Federal Power Commission urging that it require the Susquehanna Power Company to build a fish ladder at the dam if a permit to continue operations at Conowingo is to be granted.

The Fisheries Administration of Maryland's Department of Natural Resources called for a fish ladder at Conowingo when Fisheries Administrator R.J. Rubelmann said Maryland would not renew an agreement in which the power company paid the State a $4,000 annual fee in lieu of constructing the ladder. Fisheries agencies of Pennsylvania and New York, the Susquehanna River Basin Commission, and the National Marine Fisheries Service have also recommended that construction of a ladder be made a condition of any permit issued by the Federal Power Commission for operation of Conowingo Dam.

A drastic decline in the shad fishery of Maryland has occurred within the last 5 years, dropping from over a million pounds annually to 180,936 pounds last year. The Mid-Atlantic Fishery Management Council is made up of members from New York, New Jersey, Pennsylvania, Delaware, Maryland, and Virginia in addition to the regional director of the National Marine Fisheries Service.

Pacific Coast Troll Salmon Catch Reviewed

Preliminary estimates of the troll catch of chinook (king) and coho (silver) salmon for Alaska, British Columbia, Washington, Oregon, and California for 1976 reached 64.5 million pounds, according to data compiled by David W. Ortman, Idaho Fish and Game Department, for the Pacific Marine Fisheries Commission. The 1976 total is up almost 2 million pounds from the 10-year average catch of 62.7 million pounds. Chinook catches at 26.3 million pounds were less than the 10-year average of 27.1 million pounds. Coho catches at 38.2 million pounds exceeded the 10-year averages in all regions except British Columbia.

TROLL CHINOOK FISHERY

Alaska's troll-caught chinook landings were about 3.9 million pounds in 1976. This was less than the 4.3 million pounds for 1975 and the 5.1 million pounds for 1974. The 10-year average is 4.3 million pounds. The chinook landings by British Columbia troll fishermen were 11.4 million pounds. This was down 800,000 pounds from 1975 and was 700,000 pounds less than the 10-year average. Washington's 1976 troll chinook landings were 4.6 million pounds, 2.0 million pounds more than 1975 and 1.9 million pounds greater than the 10-year average.

Oregon's troll chinook landings for 1976 will be about 2.1 million pounds. This will be about 900,000 pounds less than the 1975 landings and 200,000 pounds larger than the 10-year average of 1.9 million pounds. The troll season opening was delayed this year from 15 April to 1 May. In addition, a small part of the Oregon coast from Tillamook Head to the mouth of the Columbia River was closed from 15 June to 1 July. These changes made a small reduction in catch.

The estimated 1976 California troll chinook landings are 4.3 million pounds. This represents the poorest chinook landings since 1958 when landings totaled only 4.1 million pounds. San Francisco-Monterey area trollers landed only 2.3 million pounds of chinook, down 100,000 pounds from 1975. San Francisco-Monterey area landings amounted to only 50 percent of the 10 year average for that area.

TROLL COHO FISHERY

Alaska's 1976 troll coho landings were about 4.7 million pounds compared to 1975 landings of 1.5 million pounds. The figure was approximately 17.5 percent above the 10-year average of 4.0 million pounds. British Columbia's troll coho landings for 1976 are expected to be about 12.1 million pounds. This will be 3.0 million pounds more than the 1975 landings and 4.9 million pounds less than the 10-year average of 17.0 million pounds.

Washington's troll coho landings for 1976 totaled about 7.2 million pounds, approximately 1.8 million pounds above the 10-year average. Oregon's troll coho landings for 1976 will be about 10.5 million pounds, a record high. This will be about 5.8 million pounds above the 1975 landings and 4.0 million pounds larger than the 10-year average.

California's troll coho landings were 3.7 million pounds, the fourth highest year on record. This is significantly better than 1975 landings of 1.3 million pounds and the recent 10-year (1966-75) average of 2.7 million pounds. The leading port was Eureka with 1.5 million pounds followed by Crescent City with 750,000 pounds. Approximately 92 percent of California's statewide coho landings were landed during the first 2 mo (15 May-15 July) of the coho season.

Publications

NMFS Scientific Reports Published

NOAA Technical Report NMFS CIRC-396. Leatherwood, Stephen, David K. Caldwell, and Howard E. Winn. **"Whales, dolphins, and porpoises of the western North Atlantic. A guide to their identification."** August 1976. 176 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

ABSTRACT

This field guide is designed to permit observers to identify the cetaceans (whales, dolphins, and porpoises) they see in the western North Atlantic, including the Caribbean Sea, the Gulf of Mexico, and the coastal waters of the United States and Canada. The animals described are grouped not by scientific relationships but by similarities in appearance in the field. Photographs of the animals in their natural environment are the main aids to identification. A dichotomized key is provided to aid in identification of stranded cetaceans and appendices describe how and to whom to report data on live and dead cetaceans.

NOAA Technical Report NMFS Circular 397. Larson, Ronald J. **"Marine flora and fauna of the northeastern United States. Cnidaria: Scyphozoa."** August 1976. 18 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

ABSTRACT

This manual is an introduction to the scyphomedusae found in coastal waters from Maine to the Chesapeake Bay. It includes a discussion of their identification, collection, rearing, preservation, and nematocysts. Also included is an introduction to the natural history of the scyphopolyps and medusae, a discussion of stinging scyphomedusae, a glossary of terms, an illustrated synopsis of ephyrae, an illustrating key to the scyphomedusae (including the Stauromedusae), an annotated systematic list, a bibliography of major references, and finally an index.

NOAA Technical Report NMFS SSRF-703. Vondruska, John. **"Aquacultural economics bibliography."** October 1976. 123 p.

ABSTRACT

This aquacultural economics bibliography includes recent published and some unpublished United States and foreign literature (originally in or translated into English). Based upon U.S. aquacultural activity and interests, the 262 entries are listed alphabetically within eight categories: catfish, trout, salmon, oysters and other mollusks, shrimp and other crustaceans, other animal species, seaweeds, and general. Included literature concerns production economics, methodology, demand, supply, markets and marketing, institutions, constraints, state of the art, investment analysis, data, and other subjects. Some entries are general, or primarily descriptive, or of primarily noneconomic content.

Catalogs of Specialized U.N. Books Are Available

Catalogs describing publications of two specialized agencies of the United Nations, the Food and Agriculture Organization (FAO) and General Agreement on Tariffs and Trade (GATT) have now been published.

"FAO Books in Print, 1976-77" is an 87-page catalog covering such subjects as world agriculture, food and nutrition, plant and crop science, animal science, forestry, fisheries, land and water management and conservation, commodity production and marketing, pest control, farm management and rural development. Publications include monographs, series publications, manuals, periodicals, and statistical compilations. Titles are indexed by author and by subject.

"Publications of the General Agreement on Tariffs and Trade, 1976" describes available titles of interest to the business, finance, marketing, and export/import community. Publications cover decisions, resolutions, recommendations, and reports adopted by the Contracting Parties to GATT; international trade by commodity, region, and country; trade in agricultural products; trade of developing countries; tariff structure, schedules, and protocols.

Both catalogs are available free on request from Unipub, exclusive U.S. distributor for FAO and GATT publications. Send requests to: UNIPUB, Box 433, Murray Hill Station, New York, NY 10016.

SALMONID CULTURE HANDBOOK UPDATED

The long-awaited Fish Bulletin 164, "Trout and Salmon Culture (Hatchery Methods)," is now available, the California Department of Fish and Game has announced. Bulletin 164, which replaces Bulletin 107, is available at $3 per copy from the Office of Procurement, Documents Section P.O. Box 20191, Sacramento, CA 95820. Bulletin 107 has been out of print for several years, the DFG said.

Lugworm Culture Methods and Economics Detailed

For years the lowly lugworm has been used as a major bait by both commercial and sports fishermen in the British Isles, on the European continent, and in Korea, Japan, and South Africa. But, because they are difficult to harvest in the U.S., lugworms are used only occasionally as bait. Instead, bloodworms and sandworms are North America's major bait worms and they are used chiefly along the east coast between New York and North Carolina and on the California coast where they sell for about $1.85 per dozen. Demand often exceeds supply which forces prices up still further.

For the past 3 years, however, researchers at the University of West Florida, under funds from the Florida Sea Grant Program, have been investigating the feasibility of raising lugworms commercially, thus making them more readily available as a sports fishing bait. Results of this research are now available in Florida Sea Grant Report No. 16, **Lugworm Aquaculture,** by Charles N. D'Asaro and Henry C.K. Chen.

According to Chen, commercial fishermen are unanimous in feeling that the lugworm is not practical for their needs because of the price which is much higher than the cut bait they routinely use. But with sport fishermen it is a different story. Their fishing time is often limited. So when they have an opportunity to fish, they want a bait that is reliable, regardless of a somewhat higher cost. Lugworms, according to D'Asaro, are delicious to the fish and are durable worms which will definitely do the job. They are particularly effective with redfish, he says.

The report not only details a hatchery plan but also contains economic data on marketing and financial aspects of lugworm hatchery operation. According to the report, one million worms must be marketed per year if the operation is to be commercially successful. To realize this level of production, approximately 1.5 acres are needed in grow-out space.

Also needed are some inexpensive plastic liners for constructing the grow-out units, the right kind of food for the worms, and of course, the necessary "know how" to make the entire system work. Not a great deal of patience is required, however, since marketable worms can now be ready for harvest in 90 days.

Single free copies of this report may be obtained from the Marine Advisory Program, G022 McCarty Hall, University of Florida, Gainesville, FL 32611.

Germany Prints Annual 1974-75 Fishery Report

The Ministry of Food, Agriculture and Forestry of the Federal Republic of Germany has published its "Annual Report on German Fisheries 1974-75." The report contains over 250 pages and is in German, with English summaries at the end of each chapter. Tables are titled in both English and German, and detail all aspects of German fisheries, including landings, trade, fleet fishermen, fishing grounds, and research. The report uses data and statistics from 1973 and 1974. For a copy of this report, write to the Federal Statistical Office, Ministry of Food, Agriculture and Forestry, Bonn, Federal Republic of Germany.

In Brief. . . .

A Blue Crab Harvest, an Aged Striper, and an Anchovy Plan

. . . . **Maryland's 1976 blue crab meat pack** was 20,885,511 pounds, according to preliminary figures compiled by the National Marine Fisheries Service in cooperation with the Fisheries Administration of the Maryland Department of Natural Resources. Though the poundage was down 19 percent from the 25,901,758 pounds of 1975, the value was up, at $5,649,968 compared with 1975's $5,145,514. The 1976 catch was below the 25 million pound average, but it was above the 1973 figure of 20,723,486 and well above the disastrous year of 1968 when only 10.3 million pounds were processed. Not tabulated was the sport crab catch and the so-called "basket trade" in which crabs are sold live or steamed. . . .

. . . . **California's Fish and Game Commission has turned down** a proposal by the Department of Fish and Game to raise this season's anchovy for reducton quota but adopted a DFG-proposed anchovy management plan, the DFG reports. The department had recommended raising the 115,000 anchovy quota for reduction to 215,000 tons a year. The management plan accepted by the commission states that an annual optimum yield of 439,000 tons is possible when the spawning population of the central stock of the northern anchovy reaches 2.3 million tons or more. Biologists now estimate this spawning biomass at from 3.5 to 4 million tons. . . .

. . . . **Raymond Schroeder, 51, of Carlisle, Ark.,** was named Catfish Farmer of the Year during the annual convention of the Catfish Farmers of America in New Orleans, La. in February, the organization reports. Meanwhile, Leo Ray of Buhl, Idaho, succeeded John Peaster of Yazoo City, Miss. as president of the organization. President-elect is S. L. Reed, Belzoni, Miss.; secretary is Foy Gilbert, Thomaston, Ga.; and treasurer is W. E. Edwards, Winnie, Texas. Mervine Anderson, secretary to Jim Ayers, fishery marketing specialist at the Little Rock, Ark. office of the National Marine Fisheries Service, was presented with a Certificate of Merit by the CFA. . . .

. . . . **Over 6.3 million salmon were caught** by sport and commercial fishermen in Washington State's waters during 1976, according to the Washington Department of Fisheries report. However, the preliminary data could be as much as 10 percent under the actual number of salmon harvested, the report cautions. Of the total, sportsmen took over 1.3 million fish with the balance taken by Indian and non-Indian commercial fishermen. For anglers and trollers, coho salmon provided recorded harvests. The previous coho catch record was in 1971 when sport fishermen caught 845,735 fish and trollers took over 1.2 million fish. Last year these groups harvested 941,897 and over 1.4 million coho respectively. . . .

. . . . **A 30-pound striped bass caught 5 December in the** Sacramento River near Garcia Bend had carried its tag for 18 years, 7 months, according to the California Department of Fish and Game. The previous record was a 33-pounder that had been at large for 17 years, 5 months. The new record setter was tagged in Broad Slough in May 1958 at an estimated age of 5 years, weighing 7.5 pounds and measuring 25 inches. Meanwhile, another striper caught in Newport Bay in November 1976, showed the farthest south movement of a striper tagged in the Sacramento-San Joaquin estuary. It had been marked 2 April 1974 near Schad Landing on the Sacramento. Most of the bass tagged in the estuary are caught in the San Francisco Bay area or in the Sacramento-San Joaquin River system. . . .

. . . . **An Almaco jack tagged and released offshore** from Charleston, S.C. 2½ years ago had tripled its weight when it was recaptured early this year in almost the same spot the Wildlife and Marine Resources Department reports. The jack weighed about 5 pounds when first taken on 4 July 1974. It weighed 15.5 pounds on 4 January 1977. . . .

. . . . **The U.S. Coast Guard is trying out its first hydrofoil,** the *Flagstaff,* to investigate fisheries violations, offshore oil spills and to respond to distress calls, according to the U.S. Department of Transportation. The agency took possession of the vessel 29 September and assigned it to Woods Hole, Mass., for duty as a law enforcement vessel. The Coast Guard is operating the 45-knot vessel for one year to assess its capabilities and limitations in supporting expanded fisheries enforcement responsibilities. . . .

. . . . **Some new 45-inch tall orange and white buoys** are guiding Galveston Bay anglers to oyster reefs, likely game fish habitat, the Texas Parks and Wildlife Department reports. While expert anglers can find the reefs without navigational aids, the P&WD explains that many newcomers are hard put to find good fishing areas. The buoys, a foot in diameter, are white with orange stripes near the bottom and top, unlighted, and carry the P&WD decal and the name of the particular reef. . . .

. . . . In Michigan, where large mesh gill nets and chub fishing have been banned, **the Michigan Sea Grant Program has begun evaluation** of purse seining gear which has never before been used in the Great Lakes. The nets have been designed by Jerry Jurkovich of the NMFS Northwest and Alaska Fisheries Center, Seattle, Wash. Primary target fish for the project are lake whitefish, round whitefish (called menominee locally), yellow perch, and mullet. . . .

. . . . **Lake trout from Minnesota's Lake Superior waters** are well within acceptable contaminant levels set by the U.S. Food and Drug Administration, the Minnesota Department of Natural Resources reports. Edible portions of 43 lake trout taken from the French River, Little Marais, and Hovland areas were analyzed for residues of PCB's, dieldrin, lindane, and mercury. Mercury levels averaged about half the 0.5 ppm "action" level set by the FDA and none of the other residues exceeded the appropriate FDA "action level" in any of the fish. . . .

. . . . **The commercial potential of underused species** such as snapper, grouper, rock shrimp, and cockles is being investigated by the South Carolina Wildlife and Marine Resources Department. The project is part of a larger program to investigate the feasibility of establishing a seafood industrial park in Beaufort County, S.C. in hopes of revitalizing the state's established fishing industry, the department notes. . . .

Erratum

In the paper entitled "Nitrite Additives—Harmful or necessary?", in the April 1976 issue (Vol. 38, No. 4) of *Marine Fisheries Review,* author Elinor M. Ravesi points out the following correction: "The third word of line 3 on page 25 should be 'lower' rather than 'higher.'"

The National Marine Fisheries Service (NMFS) does not approve, recommend or endorse any proprietary product or proprietary material mentioned in this publication. No reference shall be made to NMFS, or to this publication furnished by NMFS, in any advertising or sales promotion which would indicate or imply that NMFS approves, recommends or endorses any proprietary product or proprietary material mentioned herein, or which has as its purpose an intent to cause directly or indirectly the advertised product to be used or purchased because of this NMFS publication.

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